SYSTEMS THINKING SKILLS OF PRESCHOOL CHILDREN IN EARLY CHILDHOOD EDUCATION CONTEXTS OF TURKEY AND GERMANY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

ŞEBNEM FERİVER GEZER

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
THE DEPARTMENT OF ELEMENTARY AND EARLY CHILDHOOD EDUCATION

JULY 2018

Approval of the Graduate School of Social Sciences

Prof. Dr. Tülin Gençöz
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

Assist. Prof. Dr. H. Özlen Demircan
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

Prof. Dr. Gaye Teksöz
Co-Supervisor

Assoc. Prof. Dr. Refika Olgan
Supervisor

Examining Committee Members

Prof. Dr. Özgül Yılmaz-Tüzün (METU, ESME)

Assoc. Prof. Dr. Refika Olgan (METU, ECE)

Prof. Dr. Matthias Barth (Leuphana Uni., IS)

Assoc. Prof. Dr. Feyza Erden(METU, ECE)

Assist. Prof. Dr. Jennie Farber Lane (Bilkent Uni., ES)

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Şebnem Feriver Gezer

Signature :

ABSTRACT

SYSTEMS THINKING SKILLS OF PRESCHOOL CHILDREN IN EARLY CHILDHOOD EDUCATION CONTEXTS OF TURKEY AND GERMANY

Feriver Gezer, Şebnem
Ph. D., Department of Elementary and Early Childhood Education

Supervisor: Assoc. Prof. Dr. Refika Olgan
Co-Supervisor: Prof. Dr. Gaye Teksöz

July 2018, 409 pages

The goal of this thesis is two-fold. The first goal is to conceptualize nature of the systems thinking skills of 4- to 6-year-old preschool children. Accordingly, an individual story reading and interview session was realized with 52 Turkish and German children. Then the nature of the children's systems thinking skills were conceptualized by making use of a developmental rubric which was created as part of this study. The second goal of this study is to explore potential educational contextual key variables that may have an impact on systems thinking skills of young children. Accordingly, interaction patterns among aspects of systems thinking skills within the Turkish and German mainstream and alternative educational contexts were examined by utilizing a comparative multiple case study approach.

The findings of this study indicated that young children do show some signs of complex understanding regarding systems thinking in terms of detecting obvious gradual changes, two-step domino and/or multiple one-way causalities, and describing behavior of a balancing loop. However, their capacity was found to be limited in detecting a reinforcing loop, hidden components and processes, understanding system mechanisms, demonstrating multi-dimensional perspective, solving problem through high-leverage interventions, and predicting the future behavior of the system. In addition to these, findings indicated that age and lingual background of the child, duration of attending a preschool, facilitating children's conflict resolution, seeing and touching the systems explicitly, project-based learning, critical thinking, cognitively challenging questions, teachers and lack of systems thinking approach could be related to the systems thinking skills of children.

Keywords: Systems thinking, Early childhood education, Education for sustainable development, Preschool children

ÖZ

TÜRKİYE'DEKİ VE ALMANYA'DAKİ ERKEN ÇOCUKLUK EĞİTSEL BAĞLAMLARINDAKİ OKUL ÖNCESİ ÇOCUKLARININ SİSTEMSEL DÜŞÜNME BECERİLERİ

Feriver Gezer, Şebnem
Doktora, Temel Eğitim ve Okul Öncesi Eğitim Bölümü

Tez Yöneticisi: Doç. Dr. Refika Olgan
Tez Ortak Yöneticisi: Prof. Dr. Gaye Teksöz

Temmuz 2018, 409 sayfa

Bu doktora tezinde iki hedefe ulaşılması amaçlanmıştır. Çalışmanın ilk hedef gereği, 4 ila 6 yaş arasındaki okul öncesi çocuklarının sistemsel düşünme becerilerinin doğası kavramsallaştırılmıştır. Bu amaç doğrultusunda araştırmaya Türkiye'den ve Almanya'dan 52 çocuk katılımcı dâhil edilmiş, her biri ile bireysel hikâye okuma çalışması yapılmış, hikâyedeki sistem davranışlarını irdelemeye yönelik görüşmeler gerçekleştirilmiştir. Katılımcı çocuklarının sistemsel düşünme becerileri, bu çalışma kapsamında geliştirilen bir gelişimsel değerlendirme ölçeği kullanarak kavramsallaştırılmıştır. Bu çalışmada tanımlanan ikinci hedef gereği, erken çocukluk eğitimi bağlamları ile çocukların sistemsel düşünme becerileri arasındaki ilişki ele alınmıştır. Çocukların sistemsel düşünme becerilerine etki etme potansiyeline sahip eğitsel bağlam değişkenleri karşılaştırmalı çoklu durum çalışması deseni ile ortaya konmuştur.

Araştırma bulguları ışığında 4-6 yaş aralığındaki çocukların sistemsel düşünme bağlamında ele alınan kademeli değişimler, iki basamaklı domino ve/veya çoklu tek yönlü nedensellik ve negatif geri beslemeyi tespit etme bağlamlarında nispeten karmaşık bir anlayış sergiledikleri sonucuna ulaşılmıştır. Ayrıca, çocukların pozitif geri besleme, görünmez bileşenleri ve süreçleri tespit etme, sistemlerde gerçekleşen kasıtsız neticeleri kabul edecek şekilde sistem mekanizmalarını anlama, çok-boyutlu perspektif sergileme, yüksek tesirli

müdahalelerle problem çözme ve sistemin gelecekteki davranışlarını tahmin etme bağlamlarında kapasitelerinin kısıtlı olduğu sonucuna varılmıştır. Araştırma bulgularından yola çıkılarak çocuğunun yaşının, dil arka planının, okul öncesi eğitim kurumuna devam etme süresinin, çocukların çatışma çözme becerilerinin kolaylaştırılmasının, çocuklara sistemleri görme ve sistemlere dokunma gibi deneyimler yaşatılmasının, çocukların öğrenme deneyimlerinin proje tabanlı öğrenme yaklaşımı ile derinleştirilmesinin ve birbirleriyle ilişkilendirilmesinin, eleştirel düşünme süreçlerinin işletilmesinin, bilişsel olarak zorlayıcı sorular sorulmasının, öğretmenlerin ve eğitsel bağlamlardaki sistem anlayışı yoksunluğunun çocukların sistemsel düşünme becerilerine etki edebilecekleri değişkenler olabileceği çıkarımı yapılmıştır.

Anahtar kelimeler: Sistem düşüncesi, Erken çocukluk eğitimi, Sürdürülebilir kalkınma için eğitim, Okul öncesi çocuklar

To Ufuk

ACKNOWLEDGEMENTS

I started to work on this dissertation in Ankara. I continued working on it in Münster, Germany. I completed it in Berlin, Germany. During this process, profound changes occurred in my professional and private life. Inevitably, these changes made a direct impact over my thinking in general. In my endeavor to deal with my subject matter intensively and extensively, I had a long, arduous and exhaustive experience of writing this dissertation. The main lesson I learnt at the end of this process was that competent team work is indispensable for bringing a high quality dissertation to completion.

Throughout this whole process, I always felt the unwavering support of my dissertation supervisor Assoc. Prof. Dr. Refika Olgan and co-supervisor Prof. Dr. Gaye Teksöz. I am grateful to both of them for their keen interest and able guidance that they so generously provided to me. I have learnt and continue to learn so many things from them. I owe special thanks to Prof. Dr. Matthias Barth, who, in his capacity as my mentor, gave contextual support about Germany. All of his invaluable suggestions and insights enriched my work by opening new avenues and expanding my intellectual horizons.

I would also like to thank my committee members Prof. Dr. Özgül Yılmaz-Tüzün, Assoc. Prof. Dr. Feyza Erden and Assist. Prof. Dr. Jennie Farber Lane for their valuable contributions to my dissertation.

My heartfelt thanks go to my research partners Hatice Sever and Naima Tekgöz as well as to my reliability coders Güliz Karaaslan and Seçil Cengizoğlu. I cannot thank enough to my dear friends Hilal Yanış and Gamze Çetinkaya, who facilitated all the necessary procedures in Turkey, which otherwise would have been very difficult for me as I was living in Berlin at the time. On a personal note, I have to say that I am also very happy for we have solidified our friendship thanks to this experience.

It is a pleasure to express my gratitude to Prof. Dr. Cemal Yıldız, Prof. Dr. Yüksel Dede, Dr. Stephanie Jocobsen, Fatma Cankara, Nil Avdiç, Mine Deniz, Seçil Şen, Reyhan Thomas, Seher Şener and Akın Akarsu for their valuable support.

My beloved friends Zeynep Aydemir Koyuncu and Arzu Ceviz deserve all my gratitude for emboldening me to embark on this journey and their constant encouragement.

No words could describe how much I am indebted to my mother Nilgün Feriver and my father Ferhat Feriver, who made tremendous sacrifices for my education. It is thanks to them that I turned out to be an eternal student. My one and only sister Meltem Feriver, I have always felt your support with me throughout my education. I want to thank you for being there whenever I needed it.

I also want to thank my dearest sons Çınar and Barış for their patience and understanding in this process. We are blessed to have you as our sons. You are much loved by us.

My dearest husband Ufuk, I took on this challenge with your support. Without your help, patience and backing I would not have succeeded. Your faith in me gave me the strength to carry on. This work is yours as much as it is mine. Thus, I dedicate this dissertation to you. I love you so much.

Last but not least, I wish to thank Jean Monnet Scholarship Programme for their financial as well as intellectual contributions to my research. Thanks to the generous support of the Programme, I had the opportunity to attend Leuphana University as a visiting scholar, where I had the chance to associate with Prof. Dr. Matthias Barth, and cooperate with other colleagues in Germany, which increased the overall quality of my work.

On a final note, I want to thank the readers who reached out to this dissertation.

With the hope of creating a sustainable today and tomorrow.

Şebnem Feriver Gezer

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ECE	Early Childhood Education
ECEfS	Early Childhood Education for Sustainability
EfS	Education for Sustainability
ESD	Education for Sustainable Development
OECD	Organization for Economic Co-operation and Development
UN	United Nations

CHAPTER 1

INTRODUCTION

1.1 Background to the Research and Statement of the Problem

1.1.1 Current State of the Globe

Globalization "refers to the widening, deepening and speeding up of global interconnectedness..." (Held, McGrew, Goldblatt & Perraton, 1999, p. 14). As a striking manifestation of such interconnectedness, the growth rate of international trade has been double the rate of the global economy since 1950 (WOR, 2010). In this time frame, one-fifth of all the goods and services in the world were involved in a cross border trade transaction (Leiserowitz, Kates & Parris, 2004). Outside the linguistic, cultural and political barriers, the speed of circulation of creative work such as images, songs and words, and above all, ideas has surpassed the pace of the flow of products. Similarly, the mobility of people in search of new employment has increased, which has accelerated the rate of immigration at a striking level, particularly when compared with that of world trade (Leiserowitz, Kates & Parris, 2004).

Since globalization increases interactions among people, nations and institutions, local connectivity has been replaced by global links. These links have had overarching impacts that have been felt far and wide, rendering geographical distances to a minimum and even with the potential to influence subsequent generations. A global culture has replaced local diversity, connections and references (Sterling, 1996). Due to globalization, some researchers argue that there is a tendency towards homogeneity of values and norms (Sterling, 1996). Other scholars, however, argue that globalization actually reinforces the process whereby more space is opened for the reinvention of local identities and the further strengthening of particular identities (Mason, 2007).

One of the results of globalization is that our contemporary moment is characterized by wickedness, uncertainty, and accelerating change (Wals & Corcoran, 2012). Table 1 summarizes a typology of problems in the contemporary society.

Table 1. A typology of problems

	Simple (Easy to Solve)	Complex (Resists Solving)	Wicked (Resists Defining)
Summary	A clear problem with a clear solution	The problem and solution are not clear but can be understood with time	Problem and solution are not understood and keep shifting when we try to define them
Properties	- Predictable - Straightforward - Obvious	- Many elements, although the elements themselves are familiar - Hidden root causes - Non-linear - Inter-operating parts effect each other	- Ambiguous - Chaotic - Many stakeholders with conflicting perspectives - Many elements, many hidden and some hitherto unknown - Strong social aspect - Involves changes in belief, behavior and/or identity - No right/wrong solution - Non-quantifiable - No precedent

Source: Gibson & Fox, 2013

Current problems that our planet face today, such as diminishing biodiversity, depletion of resources, food shortages and chronical nutrition deficiency can commonly be referred as wicked problems which do not fit into a certain definition, have no single solution that works always and everywhere, utterly ambiguous, and are submerged in conflicts of interest among multiple stakeholders. The common characteristics of these issues can be "highly complex and systemic, ambiguous and contested, and urgent and existential" (Wals, 2015, p.4). Mike Toman, Research Manager of the Research Department of the World Bank, commented that one of the most vicious problems of our day is climate change, and added that huge scientific and financial tortuousness, some bottomless improbability, and intense ethical problems are displayed in climate change context, even the dispute on what the issue itself is can be observed. Anthropogenic climate change affects the globe in an undisputable way and the speed of temperature and sea level rise are linked with ecological feedback circles, which are not fully interpreted and which can increase the biosphere destabilization rate (Hansen et al., 2015). From a social point of view, the Anthropocene is an era that humanities scholar Rob Nixon (2011) identifies as 'slow violence,' or ecological hostility and environmental iniquity that emerges in spatial and temporal patterns which are mostly hard to comprehend and affect against the poorest people of the world. As Howard Odum and Elizabeth Odum (2001) wrote extensively in the text entitled “A Prosperous Way Down”, “the global society can turn down and descend prosperously, reducing assets, population, and unessential baggage while staying in balance with its environmental life-support system” (p. 3). Donella Meadows stressed the necessity for a “new way of looking” at contemporary problems and she stated (Meadows, 1982, p. 101):

> The world is a complex, interconnected, finite, ecological-social-psychological-economic system. We treat it as if it were not, as if it were divisible, separable, simple, and infinite. Our persistent, intractable, global problems arise directly from this mismatch. No one wants or works to generate hunger, poverty, pollution, or the elimination of species… Yet those results are consistently produced by the system-as-a-whole, despite many policies and much effort directed against them. Many policies work… but some problems consistently resist solution in many cultures and over long periods of time. Those are the problems for which a new way of looking is required.

1.1.2 Reaction of the International Community

The European Union (EU) issued the Europe 2020 strategy as a reaction to the above-mentioned problems. This strategy underlines smart, sustainable and inclusive development as a tool to conquer the structural inadequacies in the economy of Europe, which is a way to restore its competitiveness and productivity and maintain a sustainable social market economy. There are five main target fields in this strategy: Employment, Research and Development, Climate Change and Energy, Education, Poverty, and Social Exclusion. When analyzed in detail, it can be seen that these fundamental fields are multilayered and have many actors, and they are included in a dynamic exchange and interaction between each other, affecting and changing one another.

As Kristin Archick, who is a specialist in European Affairs explained in the report entitled as “The European Union: Current Challenges and Future Prospects”, the EU is generally regarded as indispensable for the stability and economic well-being of Europe (2017). That stated, a number of political and economic challenges are currently testing the EU, such as slow growth and the rise of populist political parties. It is obvious that some of these developments are owed, in some measure, to the existing “euroskeptic” sentiments. As a result of these factors, the ability of the EU to live up to the task of sufficiently addressing the internal and external challenges has been weakened. Archick (2017, p.2) summarized the most prominent challenges as of 2017 as follows: (1) the June 2016 vote in the United Kingdom (UK) in favor of leaving the EU (Brexit); (2) the Greek debt crisis and lingering concerns about the Eurozone; (3) ongoing migrant and refugee flows; (4) a resurgent Russia; and (5) a heightened terrorism threat.

Some of these challenges can be described as multi-layered and complex influenced by a variety of actors, while others fall into the category of wicked problems. As the EU struggles to produce satisfactory responses to the recurring crisis, the future form and nature of the Union is a matter of a heated debate. Those who stand behind the European project are concerned that for the first time in its 60-year existence the EU may have to forego some aspects of its integration aspirations or some of the gained ground in terms of integration could even be lost. Others argue that current multiple crises could precipitate substantial reforms in the EU, which might lead to further political and economic integration, and eventually boost the effectiveness and cohesion of the Union. An additional challenge the EU has to overcome is the ubiquitous youth unemployment and the empowerment of young people in general. Unemployment rates among the young in most of the EU countries are in double digits, reaching 30% to 40% in some other countries (Heinrich Böll Stiftung, 2017). It can be stated that the schools are responsible for developing those skills in students that are required for employment and handling the challenges of everyday life. However, both the jobs and their definitions are passing through a fast transformation. Table 2 compares new and old system by focusing on the changing of jobs due to shifts in organization and management.

Table 2. How jobs are changing due to shifts in organization and management

Element	**Old System**	**New System**
Workplace organization	Hierarchical Rigid Function/specialized	Flat Flexible Networks of multi/cross-functional teams
Job design	Narrow Do one job Repetitive/simplified Standardized	Broad Do many jobs Multiple responsibilities
Employee Skills	Specialized	Multi/Cross-skilled
Workforce Management	Command/control systems	Self-management
Communications	Top down Need to know	Widely diffused Big Picture
Decision-making Responsibility	Chain of command	Decentralized
Direction	Standard/fixed operating Procedures	Procedures under constant change

Source: Plate, 2006, p. 47

As also emphasized in the 2015 Joint Report of the Council and the Commission on Education and Training 2020, education and training systems should develop their effectiveness and efficiency to increase the workforce's skill level and ability to handle skill mismatches in order to evaluate and meet better the fast changing requirements of labor markets. In a society which is becoming more and more digital and for the transition to a circular economy, this case is especially important. Hence, "improving the quality and efficiency of education and training" has been declared as one of the four primary strategic objectives in the current strategic framework for European cooperation in education and training; in other words, Education and Training 2020. According to this strategic objective, although the focus is on basic skills such as numeracy and literacy, this research considers that focusing on basic skills is pointless and there is a necessity for a teaching and learning 'of a different kind' (Schumacher, written 1974, published 1997). When the issues of our modern-day are addressed both on a regional and global scale, we are confronted with Einstein's well-known quote, "We cannot solve our problems with the same thinking we used when we created them".

Global sustainability challenges have a disproportionate effect on the young people in that they will have to live longer with the socio-ecological consequences of lifestyle and development choices of the previous generations, particularly in the wealthier parts of the planet (Wals, 2015). In the decade following the Rio Summit of 1992, a UNESCO report (2002) noted that the world has learned to live unsustainably; we now need to learn how to live sustainably. Sterling (2001) maintains that to fully implement such a learning process the ability to rise to "the challenge and opportunity that sustainability presents" is needed (p. 22). The departure point for initiating this type of learning is to realize a cultural shift that would serve to modify the way we see education and learning. This shift should be based on a more relational view of the world (Sterling, 2008). Accordingly, it is expected that educational systems, institutions and educators should be equipped to develop a systemic change in thinking and practice. As a result, a new paradigm should be born out of this process which is constructed around "holism, systemic thinking, sustainability, and complexity" (Sterling, 2008, p. 64). Thus, it has been argued that conventional curricula fail to adequately prepare students for the challenges they face in an industrialized, globalized world. In light of such developments, educators need strategies for the anticipated engagement with changing socio-ecological realities, both in the present and future, in order to be effective within their various embodied contexts. As a reaction to the problems mentioned in the previous arguments, UNESCO's Global Action Programme (GAP) was launched at the World Conference on Education for Sustainable Development (ESD) in November 2014 in Aichi-Nagoya, Japan. The principal objective of the GAP is to bring about and increase action in all levels and areas of education and learning to quicken progress towards sustainable development.

1.1.3 Role of Education

The first crucial international document that mentions the critical role of the education was *Agenda 21*, which was ratified by the ambassadors of 178 governments (BMUNR, 1992). In this document, Chapter 36 specifically underlines the role of education. In order to further reinforce the role of all forms of education in achieving a sustainable future, the United Nations (UN) launched the UN Decade of Education for Sustainable Development (DESD). According to its Action Plan, all "... DESD programmes and activities should reflect a balanced focus on education for the economic, social and environmental pillars of sustainable development, with culture as an underlying theme" (UNESCO, 2007, p. 15). However, as demonstrated by various research studies over the last thirty years, education that is designed to increase knowledge about environmental issues does not have a major effect on behaviors (Orr 2004; Rickinson, Dillon, Teamey, Morris, Choi, Sandres & Benefield, 2004) Besides, without criticism, embracing the opinion that high levels of education automatically add to addressing the challenges of local to global concepts of an unsustainable lifestyle and economy has long been refused as a reasonable stand (Feriver, Teksöz, Olgan & Reid, 2016). Conversely, Sauter and Frohlich (2013) point out that people living in the most educated countries generally have the most improved economies and a lifestyle that leaves the largest ecological footprints on Earth (Global Footprint Network, 2007). This situation can be explained through two different perspectives. First, it has been argued that beyond the educational curricula, the outcomes of schooling are also shaped by the economic, social and political structures of the respective societies (Kubow & Fossum, 2007). Second, issues of education for sustainable development are complex due to the connections between the social, economic and ecological aspects. This complexity requires a holistic approach, rather than a reductionist approach. Accordingly, it is argued that issues related with sustainability need to be approached at a systemic level (Sterling, 2001; Tilbury Coleman & Garlick, 2005).

It is accepted that ESD efforts have become more and more accepted into the mainstream; however, the common reductionist approach and analytical and piecemeal efforts create insurmountable barriers to solve sustainability problems (Ackoff, 1981). It is argued that existence of the new, reformist and innovative education attempts have only been recycling former failures of the old programs and today's problems come from yesterday's solutions (Thornton, Peltier & Perreault, 2004). In line with the previous argument, Sterling (2001, p. 14) stated:

> Most mainstream education sustains unsustainability – through uncritically reproducing norms, by fragmenting understanding, by sieving winners and losers, by recognizing only a narrow part of the spectrum of human ability and need, by an inability to explore alternatives, by rewarding dependency and conformity and by servicing consumerist machine.

Even though it is expected that students synthesize a perspective from what they learn from different disciplines, that perspective is never explicitly demonstrated to them (Forrester, 1992). Forrester mainly argues that conventional compartmentalized educational programs lack the perspective on how things change over time through the interaction of social, physical, and personal systems (1992). He explained that current education is about "snapshots" (Forrester, 1990, p. 6) rather than dynamic interacting components. Richmond (1991) highly recommended addressing similarities between disciplines rather than the celebrating the differences. Thus, it is emphasized that the systems approach does not fit a traditional education setting (Forrester, 1992). Senge (1990) illustrated the problem of compartmentalization as an attempt to divide an elephant into pieces. Obviously, dividing an elephant in half will not result in two smaller elephants (Thornton, Peltier & Perreault, 2004). In addition, the fundamental conceptualization to split the problem into small parts and then designing solutions to each element cause the roots of the problems remain unsolved. The critiques on the traditional approach towards education opened way for a growing body of literature in the sustainability discipline (Barth, Godemann, Rieckmann & Stoltenberg, 2007; Wiek, Withycombe & Redman, 2011) striving to describe capabilities and associated competences that should be focused in the educational paradigm to achieve sustainable living for all. By recognizing the significance of getting the reductionist view out of the way, Wals (2015) made use of this literature in composing an alternative way to describe such competencies. There are at least four 'dimensions' of sustainability competence (conceptual and systemic knowledge, critical thinking, change and innovation, and an ethical or existential, normative dimension) as highlighted in the following table (Table 3); and while being mutually interdependent, each competence has its own qualities and associated 'sustain-abilities' (Wals, 2015, p.12).

Table 3. Dimensions of sustainability competence and associated sustain'abilities'

Sustainability competence	Examples of sustain'abilities'
Dynamics and content of sustainability	Sustainability literacy Systems thinking Adopting an integral view *Learning to know*
Critical dimension of sustainability	Questioning hegemony and routines Analyzing normativity Disruptiveness, transgression *Learning to critique*
Change and innovation dimension of sustainability	Leadership and entrepreneurship Unlocking creativity, utilizing diversity Appreciating chaos & complexity Adaptation, resilience Empowerment and collective change *Learning to make change*
Existential and normative dimension of sustainability	Connecting with people, places and other species Passion, values and meaning-making Moral positioning, considering ethics, boundaries and limits *Learning to be, learning to care*

Source: Wals, 2015, p.11

1.1.4 Systems Thinking as a Tool for Change

The needs of the 21st century necessitate the development of the knowledge and skills to deal with the complexity of current and future problems (Benson, 2007) as presented above. The current reductionist and mechanistic way of thinking are inadequate in terms of perceiving and solving the multifaceted, fluid, and emergent nature of complex social, ecological and economic problems (Goerner, 2007; Meyfroidt, 2013; Moore & Westley, 2011; Wulun, 2007). Despite the increasing web of interdependencies due to the impact of globalization, our ability to develop a similarly comprehensive understanding of dynamic interdependencies has lagged behind, rendering today's problems to be more and more intractable (Richmond, 1993). By examining the links and interactions between elements of a system and other systems, systems thinking is becoming increasingly relevant when dealing with global challenges (Boardman & Sauser, 2008). As a trans-disciplinary construct, systems thinking has been promoted to facilitate the understanding of and a way to mitigate complex dilemmas (Bosh, King, Herbohn, Russel & Smith, 2007; Fazey, 2010). The emergence of complexity theory, quantum physics, coincides with the rise of general systems theory during the 1950s. Many researchers have argued that general systems theory has proved to be essential to grasp complex adaptive systems (CAS) (Fazey, 2010; Moore & Westley, 2011; Henning & Chen, 2012). CAS is defined as a group of individual nodes, which organize themselves on their own and communicate among each other locally to produce spontaneous and emergent outcomes (Cilliers, 1998; Edson, 2012; Gunderson & Holling, 2002; Holland, 1995).

Although there are various approaches to systems thinking, a minimal list would include the four broad skills given below in Table 4 with their descriptions (Ben-Zvi Assaraf & Orion, 2010a; Sweeney & Sterman, 2000; Waters Foundation, 2015).

Table 4. Four broad skills required by systems thinking

See whole systems and identify components within systems	This requires looking beyond isolated events to understand the broader temporal and spatial boundaries of systems as well as looking for hidden dimensions of the system.
Analyze the relationships among system components	This concerns seeing the interconnections among overlapping and nested systems as well as recognizing how the components within a system interact with each other.
Recognize how elements within a system change over time and systems can generate their own behavior	This refers to seeking the patterns of behavior by examining cyclical cause-and-effect relationships. Understanding the temporal dimension of systems can help learners to make future predictions as well as comprehend the dynamic complexity.
Recognize and challenge the boundaries of mental models	This involves being aware of the internal images of how the world works, images that limit us to familiar ways of thinking and acting.

Source: Compiled from the work of Ben-Zvi-Assaraf & Orion, 2010a; Sweeney & Sterman, 2000; Waters Foundation, 2015

1.1.5 Think Globally, Act Locally, Compare Internationally

As mentioned above, in December 2002, by Resolution 59/237, the UN General Assembly declared the years 2005-2014 the UN Decade of Education for Sustainable Development (DESD) (UNESCO, 2009). Following this, the Global Action Programme (GAP) on Education for Sustainable Development (ESD) was created to produce a tangible response to the pressing need for a new way of living which pays attention and respects the limits of our planet's resources while improving our collective well-being (UNESCO, 2017a). Accordingly, having made a commitment to intensify efforts to integrate the principles, values and practices of sustainable development into education and learning, member states decided to work together during the given years (Michalos et al., 2012). Consequently, a number of educational policy tools were applied and programs were initiated for formal as well as non-formal and informal learning (Michalos et al., 2012). At this time, the main challenge was to gauge the effectiveness of these new measures that aimed to integrate sustainable development concepts, values and competencies into the learning process with the intention of changing values, attitudes, skills, and behaviors. In view of the diverse nature of educational systems across and within countries, such an assessment can best be undertaken at a local level (Leiserowitz, Kates & Parris, 2004), notwithstanding the global characteristics of the concepts, competencies and values of sustainable development. The rationale behind working at a local level can be attributed to the existing evidence presented by Macnaghten, Grove-White, Jacobs and Wynne (1995) that indicates a strong link between nurturing sustainability values along with existing societal and personal values. There is a significant amount of research that suggests a connection between personal values and sustainability values (Macnaghten, Grove-White, Jacobs & Wynne, 1995; Horlings, 2015).

Turkey and Germany can be given as examples since these two countries have considerably different cultural, social and economic structures, and are under the obligation to ratify the Education for Sustainable Development (ESD) strategy. These countries interpret ESD within their respective paradigms and this is normal since different interpretations of sustainability exist as far as the educational policy and practice are concerned and "interpretations of sustainability are value-laden" (Fien & Tilbury, 2002, p. 3). Manifestly, the same body of ideas, when being put into practice in different educational systems, are interpreted diversely depending on the cultural and normative contours of different societies. This situation causes the creation of diverse strategies and visions for ESD at international and intra-national levels. Therefore, using a comparative method to analyze these strategies may shed light on how the ESD perspectives are being integrated into different educational systems. In addition, comparative inquiry may provide insights into different practices to explore the interaction between educational contexts and the skills of the children.

For instance, as stated by the portal of the Federal Ministry of Education and Research in Germany (BNE-Portal, 2017), through the adoption of the National Plan of Action, which also contains tangible measures to be taken in the field of early childhood education, necessary structures to implement the Global Action Programme on ESD in Germany has been already established. Concomitantly, ESD has been integrated to the ECE curriculum which is in use in different federal states. Identified as a partner country, Turkey is supposed to mainstream ESD into both education and sustainable development policies (UNESCO, 2017a). Nevertheless, Turkey’s national implementation reports to the United Nations Economic Commission for Europe (UNECE) Steering Committee for ESD in 2007, 2010 and 2015, indicate that ESD is still perceived as an adds-on component in terms of policy-making attempts whereby it is not easy to follow the practical implementations to make progress in the area of ESD. The possible effects of differences of policy and implementation levels on young children’s skills in these two countries is one of the significant dimensions of this study. Thus, a comparison between these two countries which have different levels of background and experience in this field could be beneficial for know-how transfer and exchange of experiences.

1.1.6 Considering the Importance of the New Generation to Reach Sustainability

Enhancing the educational contexts to enable children to deal with sustainability issues starting from an early age with the purpose of educating them as critical thinkers, change-makers and models of sustainable behavior has been arguably one of the most effective ways of addressing the wicked sustainability problems (Davis & Elliott, 2014). Recent research in early childhood education for sustainability (ECEfS) has been underlying the significance of ‘start early’. Accordingly, attempts to understand young children’s skills related to sustainability issues have become a significant interest for promoting sustainable living (Evans, Banerjee, Huxley & Leese, 2007). Arguably there are two fundamental motivations behind this attempt. First, it is considered that early childhood is a period in which the foundations of thinking, being, knowing, and acting are established; meanwhile, relationships with others and the environment are also developing (Samuelsson & Kaga, 2008). Second, this period establishes the foundations for adult activism around sustainability issues (Chawla, 1998; Davis & Gibson, 2006). However, little information on early childhood environmental attitudes and behaviors is available (Evans, Banerjee, Huxley & Leese, 2007; Soydan, 2014). Recent studies on young learners strongly suggest that this new generation appears to hold the potential to make a difference in terms of more sustainable living (Bonnett, 2002).

As Forrester (1992) stressed, children in kindergarten are already capable of observing the interpersonal relations among and between family, school and society. Benson (2007), Lyneis (1995), Sweeney (2001) and Senge (in Sweeney, 2001) agreed with Forrester’s ideas by stating that children are natural systems thinkers and they are ready to make connections, understand the big picture, and share their interpretations. As Peter Senge described in the forward of the Dutch book, “Natuurlinjk leren: Systeemdenken in een lerende school” by Jan Jutten (2004):

> Children do not have to be taught to interpret their reality. They are doing it continuously. But their ability to steadily expand this instinctive sense making into more and more complex subjects must be developed over time. Failure to do so contributes to the growing gap between the complexities of our world and the understanding of our citizens... No one can say just how far a true systemic education process can go toward developing new levels of collective intelligence. But it does not seem an exaggeration to say that our future depends upon it.

Benson (2007) highly recommended that educators should not underestimate the capabilities of children and she explained that in many Waters Foundation demonstration schools conventional age-appropriate instruction has been replaced with developmentally instruction. In this way, this presents a challenge to early childhood educators who were schooled in Piagetian theories. For example, line graphs are not seen as age-appropriate tools for Early Childhood Education (ECE) conventionalists due to the argument of the lack of abstraction level of young children. In systems thinking, preschool classrooms, drawing and sharing behavior-over-time graphs of story elements as well as causal loop archetypes are being used widely and commonly. It has been recorded that in those classrooms children as young as five years old are sufficiently qualified to solve complex problems, develop big ideas, and connect classroom applications with real-life situations.

As explained above, children are framed as innately systems thinkers according to Forrester, Senge and Sweeney, who are important and frequently referred to in the systems thinking field. The nature of this skill in childhood, which is postulated to exist in children, is very puzzling. This is because most of the recent studies claim that young children do have serious limitations in demonstrating this higher-order thinking skill. Given the complexity of this thinking approach, there is and will be an ongoing need for more research in the field. Afterall, in the systems thinking field, there have been limited empirical studies within K-12, particularly at the early childhood education level (LaVigne, 2009). In that sense, it is thought that the studies that would be conducted against the background of different educational contexts, could make significant contributions to understanding the nature of the systems thinking skills of young children as well to gaining an insight about the educational contextual key variables which might interact with this skill.

In this regard, given the differences of respective ESD policies and the diverging ECE patterns in two countries, the comparison of the Turkish and German educational contexts can present more meaningful implications. In addition to the ESD policies and implementation, there are also differences between these two countries in terms of the history of ECE as well ECE participation patterns (see the findings section of this study for more details). Kindergartens and nurseries in Germany were first established in the 19th century (Kamerman, 2006) and this service has been publicly funded and privately delivered. As explained in the European Commission Report on Early Childhood Education and Care (2014), the most common way to ensure ECE for all children is establishment of a legal entitlement[1]. In Germany, according to the defined legal entitlement, children who are 3 years old are supposed to start ECE and receive this service for 40 hours per week (European Commission, 2014).

In the 19th century Ottoman Empire, children from the age of five were given a kind of ECE at schools called *Sibyan Mektebi*, which preceded the modern ECE institutions. Only available to a minority of children, this education was comprised of mostly nursery services (Çelik & Gündoğdu, 2007). ECE was side-lined in the first periods of the Turkish Republic (founded in 1923) due to the necessity of prioritizing primary education (Bekman, 2005). At that time, there were 5,880 children enrolled in 80 nursery schools in 38 cities. It was only in the 1990s that ECE programs began to be conducted through institutionalized mechanisms. In contrast with Germany, there is no legal entitlement defined for ECE in Turkey, which means that this service is not compulsory and not accessed by most children (European Commission, 2014). However, it should be noted that there is an attempt to obligate children in Turkey to receive one-year ECE before starting primary school. Still it is accepted that ECE in Turkey is at a preliminary stage of development, especially in terms of the low level access to high-quality opportunities for young children.

To conclude, changes in the global structure of social, political and economic processes offer an important opportunity to restructure the function of education to shape current and future societies. It can be argued that such a restructuring can be achieved by incorporating a cross-national dimension into education. In so doing, the current research examines different educational contexts both at the national level as well as at the international level. This examination takes place using a comparative case study in order to extend and deepen the understanding of the world (Eckstein, 1983). This attempt may provide useful insights

[1] Legal entitlement to ECE refers to a statutory duty on ECE providers to secure publicly subsidized ECE provision for all children living in a catchment area whose parents, regardless of their employment, socio-economic or family status, require a place for their child.

to decision-makers and educators to compare policies, practices and outcomes of schooling and foster understanding of the factors that may have an impact on the improvement of education for sustainability practices.

1.2 Aim of the Study and the Research Questions

As explained in the problem statement part of the study, despite being considered important, the integration of systems thinking into education can still be described as limited (Jacobson & Wilensky, 2006; Plate, 2010); however, there is an agreement on the significance of the systems thinking in dealing with the complexity of the coming century (Meadows & Wright, 2008; Plate, 2010; Senge, 1990). Thus, the goal of this doctoral research project is two-fold. The first goal is to conceptualize the nature of the systems thinking skills of 4- to 6-year-old preschool children. It is thought that the findings of this attempt will provide a significant platform for further learning and development policies and experiences to be created for children. In this regard, within the confines of this study, first an individual story reading which was based on the premise of limits to growth system behavior was realized with the child participants. Following that, individual interviews centered on this story were conducted with the children. Then the nature of the children's systems thinking skills were conceptualized in the context of different aspects of systems thinking by making use of a developmental rubric which was created as part of this study.

The second goal of this study is to scrutinize the real-life early childhood educational contexts and then to explore the key variables that are relevant for developing educational policies and classroom applications to enhance the systems thinking skills of the children. In so doing, interaction patterns among aspects of systems thinking skills within the Turkish and German educational contexts are examined by utilizing a comparative multiple case study approach. Germany, an EU member state, and Turkey, an EU candidate state, are compared within the scope the research, because in Germany and in Turkey, children are from different educational paradigms in the context of having access to ECE, as well as being exposed the principles and applications of the ESD. In addition to these, there are also differences between Turkey and Germany in terms of systems thinking. In this regard, the importance of systems thinking in education has been long recognized in Germany, while the subject has only recently begun to receive attention in Turkey. For the first goal, it was decided to choose learning groups from the learning environments that reflect the general characteristics; that is, the ‘prototypical value’ of the mainstream preschools in which children of university educated parents attend[2]. For the second goal, learning groups in alternative education preschools that can be considered as compatible with the ESD approach which is likely to support systems thinking were selected, since systems thinking is perceived as an essential part of schooling for sustainability (Center for Ecoliteracy, n.d.). Consequently, the aim of the sampling that was performed in the current research was to compare and contrast the effect of different pedagogical approaches on the systems thinking skills of young children. These contrasts constitute the main construct of the comparative and exploratory nature of this study. By targeting researchers working in the field of ECEfS, educational policy-makers and teachers as well as young generation, this study aims to offer them an opportunity to develop a new approach to designing learning experiences to equip children towards resolving contemporary complex and wicked challenges.

Thus, the study addresses the following questions:

1. What are the levels of systems thinking skills of 4- to 6-year-old preschool children in Turkey and Germany?

    1.1 How systems thinking skills levels of 4- to 6-year-old preschool children in Turkey and Germany change according to age, gender, language background and parental education level?

2. What are the interaction patterns among aspects of systems thinking skills and Turkish and German educational contexts?

    2.1 What are the key variables that define the interaction patterns among systems thinking skills levels of 4- to 6-year-old preschool children and educational contexts in Turkey and Germany for developing ESD educational policies and classroom applications?

3.1. What are the levels of systems thinking skills of 4- to 6-year-old preschool children across mainstream and alternative cases from Turkey and Germany?

[2] The level of education of the parents is one of the most significant influences on the cognitive development of the child (Ardila, Rosselli, Matute & Guajardo, 2005). Highly educated parents tend to provide environments with more intellectual stimuli for their children (Hoff, 2003a, 2003b). Given these facts, the investigator of the study decided to work with the children of university educated parents since systems thinking skill is considered as a higher-order cognitive skill.

3.2. What are the characteristics of the educational contexts of mainstream and alternative cases from Turkey and Germany?

3. 3. What are the similarities and differences within:

3.3.1 mainstream and alternative education cases from Turkey vs. mainstream and alternative education cases from Germany?

3.3.2 mainstream education case from Turkey vs. mainstream education cases from Germany?

3.3.3 alternative education case from Turkey vs. alternative education case from Germany?

1.3 Significance of the Study

This study intends to conceptualize preschool children's systems thinking skills by describing and comparing German and Turkish educational contexts. In view of the fact that only a limited number of researchers conducted cross-case comparison in ESD, this method is perceived as a "desideratum" (Barth & Thomas, 2012, p.751). Notwithstanding the importance of the integration of systems thinking into education, its application is very limited (Jacobson & Wilensky, 2006; Plate, 2010). This study is a first which aims at revealing the interaction patterns between the systems thinking of preschoolers and preschool educational contexts through a comparative approach by looking at two countries. Investigation of preschool children's systems thinking is very important and there are various factors underpinning this statement. First, since ECE supports the intellectual, psychological, emotional, social and physical development and lifelong learning, it has great potential to foster values, attitudes, skills and behaviors which support sustainability. As explained above, young generation-themed studies display an important potential for a more sustainable future and sustainable society. Second, according to Haddad (2008), ECE is more closely related to the perspective of sustainability than other levels of formal education because formal education systems are mainly dedicated to academic learning. Furthermore, ESD touches upon all aspects of a person (Samuelsson & Kaga, 2008) and ECE for sustainability is more than simply taking children outdoors to enjoy nature and talking about the natural environment. Rather, it is about engagement of children in discussions about sustainability and in positive actions regarding environment, society and economy. In addition, it incorporates learning which includes respecting differences, notions of equality and fairness in a world that is increasingly interdependent and inter-connected (Samuelsson & Kaga, 2008).

Educational contexts are extremely crucial components of learning towards sustainability. Teachers in these contexts are the leading actors in children's learning and their development process; they are vital for the success of an educational system (Hanushek, Rivkin & Kain, 2005). In this respect, ECE teachers have a key role in providing children with opportunities in the framework of sustainability; young children benefit from a well-planned curriculum that both supports and challenges them (NAEYC, 2009). Accordingly, this research aims to guide preschool administrators and educators in how to encourage young children to build and develop sustainable lifestyles.

As mentioned before, ESD is a value-laden perspective (Fien & Tilbury, 2002). As a result, sustainability is translated into educational policies in different countries in various ways. The differences in ESD policies are further exacerbated by the teachers' varying interpretations. Furthermore, the effect of prevalent norms, attitudes and skills of societies upon children who are developing their own systems thinking skills deserves more attention.

Finally, the current study intends to emphasize the role of young children in sustainability issues. Research in this area lacks the extensive involvement of preschool children as participants of a sustainable society. As Davis (2009) noted in a preliminary survey of the literature conducted between 1996 and 2007, the subject of ECE for sustainability constitutes less than 5% of the articles in international research journals on ECE and environmental education. Accordingly, it is believed that exploring and comparing preschool children's systems thinking skills in the Turkish and German context is noteworthy. As it was connoted previously, contrasting characteristics are displayed in sustainable development in addition to ECE and systems thinking fields in Germany and Turkey. Sustainable development has long occupied the center of European Union project and the EU has a strong connection to sustainable development which is strongly linked to European Treaties. Thus, an EU Sustainable Development Strategy was started in 2001, revised in 2006 and reviewed in 2009. Since 2010, sustainable development has been made widespread with the Europe 2020 strategy, approved by the current Commission and established upon education and innovation ("smart"), creating jobs and mitigating poverty ("inclusive"), low carbon emissions, climate resilience and environmental impact ("sustainable"). According to the UN 2030 Agenda for Sustainable Development, Europe 2020, Education and Training 2020 frameworks, which are significant documents that shape our daily lives and future, humankind has to confront many sustainability challenges from youth unemployment to ageing populations, climate change, pollution, sustainable energy and migration. It is believed that to approach these challenges from a comparative point of view, underlining the interactions, performing know-how, and experience exchange will lead to more positive results than fragmentalist approaches. When viewed from this perspective, it is thought to be meaningful to display an interactive approach by zooming in and zooming out to the preschool learning groups at a micro level and approach the German and Turkish education systems from a meso level and global education from a macro level. It is also considered that young children's skills can be influenced by various factors within distinct cultural and educational contexts because society's socio-cultural worldview that supplies the context within which education functions deeply affects education (Banathy, 1991). In addition to the value which will be created on a global scale by this research, it is also speculated that the study will also offer significant insights to the educational policy-makers both in Turkey and Germany.

The importance of systems thinking has been discussed in varying academic and applied fields including education. It has been argued that the use of the systems thinking approach is a promising perspective in terms of pedagogical framework (Hammond, 2003; Senge, 1990; Senge, Aleiner, Roberts, Ross & Smith, 1994; Waddock, 2006) and this approach is being integrated to instruction and school improvement efforts (Benson, 2007). According to Porter and Cordoba (2009), the systems thinking approach has the potential to become a guiding principle for children to help them understand and appreciate the complexity and tensions existing in sustainability-related issues. There seems to be an agreement among system dynamists on the argument that systems thinking skills increase understanding of complex problems (Maani & Maharaj, 2004). This characteristic of systems-oriented education is of utmost importance in terms of environmental education since environmental systems are complex and their outcomes are difficult to predict (Grant, 1998). According to Forrester (2008), systems-oriented education provides “students a more effective way of interpreting the world around them” (p. 2). In the systems thinking classroom learning environment, children have the opportunity to practice problem-solving attempts, they are exposed to interdisciplinary connections, and they are urged to make in-depth analysis through though-provoking dialogues (Benson, 2007). Since seeing the patterns and the big picture is imperative for the success in the future (Pink, 2005), aiming to help the children to become systems thinkers is perceived as a meaningful attempt (Yates & Davidson, n.d.). Classroom applications have demonstrated that systems thinking helps students to further their critical thinking and problem-solving skills (Lyneis & Fox-Melanson, 2001). It is reported that in schools applying a systems thinking approach, students ask better questions and become more capable of recognizing patterns and connections throughout subjects. In addition, Mandinach and Cline (1989) support the opinion that systems thinking perspective can be used with both low and high ability learners and it seems that use of systems approach results in promising outcomes for less able learners.

As explained above, the added value and the utility of systems thinking are being recognized by a number of academics. However, the amount of empirical research is still largely inadequate (Delauzun & Mollona, 1999; Maani & Maharaj, 2004), especially at the preschool level. In addition, many authors have argued that the research about systems thinking and teaching in this approach is still at an early stage (Forrester, 2007a, 2007b; Jacobsen & Wilensky, 2006; Wu, 2010; Yoon, 2008). Although there is an agreement among systems researchers on the argument that systems thinking skills are essential in terms of dealing with complex problems, quantitative evidence regarding the effective systems interventions is limited (Doyle, Radzicki & Trees, 1998). As stated by Doyle, Radzicki and Trees (1998), "there is insufficient evidence to convince skeptical, scientifically minded observers, which is crucial if systems thinking ideas and techniques are to become more widely accepted in educational and corporate settings" (p. 254). Thus, more empirical evidence supporting systems thinking as a tool is required to develop effective interventions (Skaza & Stave, 2010). In this regard, as it is done in this study, exploring systems thinking skills of children from different age groups in real-life situations can lead to meaningful outcomes.

1.4 Definition of Key Terms in the Study

Early Childhood Education. ECE is an educational interaction taking place in young children's different living environments, aimed at promoting their balanced growth, development and learning (Heinämäki, 2008).

Education for Sustainability. Sterling used sustainability education to include the terms "environmental education" (EE), "ESD, EfS and "education for a sustainable future". According to his definition, this education is "a change of educational culture which both develops and embodies the theory and practice of sustainability in a way which is critically aware. This would be a transformative paradigm which values, sustains and realizes human potential in relation to the need to attain and sustain social, economic and ecological wellbeing, recognizing that they are deeply interdependent" (Sterling, 2001, p. 22).

Sustainability. In this research, the researcher developed her own synthesis of the definition of sustainability as "a radical shift of world view that includes rethinking of most patterns of human activity, towards the satisfaction and improvement of the condition of the ecosystem socially, economically and ecologically" (Feriver, 2010, p.12).

Feedback loops. According to Sweeney (2001), feedback loops are circular cause and effect relationship in which the effects return to their cause and generate either more or less of the same effect. Two types of feedback loops are found in the universe: reinforcing and balancing, also called positive and negative feedback loops. When a change occurs within something, over time this change returns to evoke a further change in that very thing; then, a feedback loop emerges. A positive or reinforcing loop emerges if that further change is in the same direction. A negative or balancing loop, also called a goal-seeking loop, emerges when it is in the opposite direction.

Systems Thinking. "Systems thinking is a group of synergistic analytic skills which are utilized to increase the capableness of specifying and comprehending systems, anticipating their behaviors, and inventing modifications to them for generating desired influences. These skills perform as a system together" (Arnold & Wade, 2015, p. 675)[3].

The Mainstream Preschool Learning Group. This term describes the preschool groups that closely follow the Ministry of National Education Early Childhood Education Program (2013) conceived centrally in Turkey, and the Berliner Bildungsprogram in Germany constructed federatively by the Berlin Federal Ministry of Education3. No alternative perspective is applied in the school in generating the structure and learning experience of the preschool education.

The Alternative Preschool Learning Group. This term refers to the preschool groups that follow the Ministry of National Education Preschool Education Program in Turkey and the Berliner Bildungsprogram in Germany; however, the components of the preschool and learning experiences have been designed in accordance with the principles of ESD with an alternative and sometimes critical view of the traditional curriculum.

---

[3] Detailed description of this term is provided in the literature review chapter.

1.5 My Motivation for the Study

Since more than a decade, I have taken part in several projects in the field of Education for Sustainable Development in cooperation with various organizations and donors. Throughout this period, I remained in contact with the educational policy makers, school administrators and teachers as well as children in educational contexts. For a long time, I have been focusing on the concepts of critical thinking and transformative learning as important components of ESD. In this regard, I have been following the studies, which look at how the ESD's theoretical principles could be translated into concrete actions in classrooms. I believe that current educational services provided to children fail to equip them with the skills and abilities to confront with present and future complex problems. I am of the opinion that today's education falls short of supporting children to fulfil their full potentials. I consider most of what is being presented as educational concept as nothing but imitations of a wrongly configured unsustainable system. While acknowledging the significant progress achieved in the field of ESD, I still think that we have a long way to go in order to reach "education of a different kind". For I came to conclusion that because of the excessive attention given to disparate fragmented issues we are risking of missing the bigger picture. In this sense, I believe systems thinking in early childhood offers new opportunities to educators and educational policy makers in terms of enabling children to transform the unsustainable human-made systems into sustainable systems through a new educational paradigm.

Although I had a difficult time to fully comprehending systems thinking in the process of determining the topic of my PhD thesis, I realized that it was relatively easier for me to embrace what systems thinking suggests in terms of how to design education. I now think that I had a hard time in understanding systems thinking simply because it was challenging me to think in a completely different way as opposed to what I was used to. In that respect, I believe that there are several reasons why it was not immediately easy to accept what systems thinking suggests in education. Within the paradigm of systems thinking, the importance of the lack of holistic thinking is underscored. Learning experiences are more holistic, connected, meaningful, real-life relevant, critical and in my opinion transformative. It is precisely for this reason I believe that systems thinking can lay the foundations of a new pedagogy which challenges human-made unsustainable systems in order to usher in a sustainable today as well as future.

I was driven to conduct this thesis study after the realization that there was a significant void in the field of early childhood education at a time when systems thinking has been gaining prominence in the educational paradigm. Throughout the course of my literature review, I critically examined and became skeptical about the statements of the leading figures of the field claiming that young children were natural systems thinkers or they had a potential therein. In order to test the validity of these claims I went on searching for any empirical research which could back them up. However, I saw that there was not any empirical research which can be referred to in arguing that young children were natural systems thinkers or innately possessed a potential there. As someone who is familiar with the developmental features of early childhood period, I started to question the possibility of natural existence of this skill, which is defined as a higher-order thinking skill, among the children who are in their early childhood period. Because of my conviction that when the initial systems thinking skills of young children have been conceptualized, there could be implications on educational paradigm, I turned the focus of my study to 4-6 year old children. That produced the first component of this study. I have constituted the second component with the help of my foresight that meaningful implications in context construction can be achieved by revealing the interaction patterns between children's systems thinking skills and educational contexts and by exploring key variables in this regard.

The outcomes of schooling are shaped by the economic, social and political structures of the societies (Kubow & Fossum, 2007). For that reason, I came to conclusion that educational applications in different countries could present a broader perspective in terms of highlighting the interaction patterns between systems thinking and educational contexts. That was the third component of my study. I decided to conduct my thesis in a comparative setting by looking at Germany where I currently reside and my home country Turkey. The reason why I made that choice is the contrasting features of these two countries. Germany is in a more advance stage than Turkey in terms of early childhood education, education for sustainable development as well as systems thinking. Meanwhile Turkey is still in an early stage in all of those areas. Thanks to these contrasts, I foresaw that the outcomes of the study could bring in deeper insights and in return could support the development of educational implications in both countries.

Last constituent which gave shape to my study is to do with how the educational policies are interpreted by the educational practitioners. Generally speaking, I came up with two broad categories where there are those who implement the policies as they were presented without questioning them and those who approach the policies critically and transform them if necessary. I have had the opportunity of observing on the ground first hand that there were huge differences between the educational outcomes in these two categories. I also made sure that these findings were corroborated theoretically by various academic studies. In this respect, I decided to add yet another contrast to my study, namely the comparison between the mainstream education and alternative education learning groups. In conclusion, I tried to write a multilayered, multicomponent, holistic and intensive thesis which aims to address the shortcomings in systems thinking in early childhood education for sustainability literature.

CHAPTER 2

LITERATURE REVIEW

The ultimate goal of this thesis is to conceptualize the nature of young children's systems thinking skills and explore the potential educational contextual key variables that may have an impact on those skills through a comparative lens in order to empower ECEfS researchers, educational policy-makers and early childhood educators to equip children to contribute to the construction of the sustainable future. Accordingly, this literature review begins with the description of the current international agenda on the Sustainable Development Goals (SDGs). Following this description, the country-level implementations in the field of Education for Sustainable Development (ESD) in Turkey and Germany are given. Thereafter, a short summary of systems thinking history and detailed description of the systems thinking is presented. Then, the relationship between systems thinking and sustainability is elaborated through education for sustainability perspective. In the last part of the literature review, studies focusing on systems thinking in educational settings conducted by other researchers are presented.

2.1 Aiming to Achieve the Sustainable Development Goals

As clearly explained in the UNESCO (2017b) document entitled "Education for Sustainable Development Goals: Learning Objectives", worldwide issues specified within the presentation section of the proposal such as climate change, necessitates a rapid change in people's lifestyles and a change in the way we think and act. To realize this adjustment, brand new abilities, morals and demeanors that result in more feasible social orders are needed. Hence, a change in the framework of education is strongly recommended to respond to this critical issue. The current 2030 Agenda for Sustainable Development (UN, 2015) precisely mirrors this vision of the significance of appropriate educational action. On 25th of September 2015, the United Nations (UN) General Assembly embraced the 2030 Agenda for Sustainable Development (UN, 2015). This modern worldwide system aimed to direct humankind towards a sustainable path. Seventeen (SDGs were at the center of the 2030 Agenda. These widespread, transformational and comprehensive SDGs aimed to achieve a maintainable, tranquil, affluent and equal life for everybody in the world both now and in the future. In those objectives, the natural limits and basic limits for the utilization of natural assets were also clarified. Also, in the SDGs are discussed important systemic obstructions to sustainable advancement such as disparity, unsustainable utilization designs, frail regulation capacity and natural debasement.

The aforementioned UN report characterized education as both an objective in itself and a tool for achieving the SDGs; thus, this is not simply comprehended as a fundamental portion of sustainable development, but a main enabler for the process. This is why education is considered as a fundamental technique within the pursuit of the SDGs. Unfortunately, as discussed in Chapter 1, not all education systems embrace the concept of sustainable development. ESD advances the ideas of the integrity of nature, economic reasonability, and a fair society for current and future humankind and has the potential to engage learners in gaining skills and undertaking activities in complex circumstances in a sustainable way:

> What ESD requires is a shift from teaching to learning. It asks for an action-oriented, transformative pedagogy, which supports self-directed learning, participation and collaboration, problem-orientation, inter- and transdisciplinarity and the linking of formal and informal learning. Only such pedagogical approaches make possible the development of the key competencies needed for promoting sustainable development (UNESCO, 2017b, p. 7).

To that effect, ESD is accepted as a key component of quality education and a vital enabler for sustainable development since it has the potential to create cross-cutting main competencies for sustainability that can be connected to all SDGs. The following eight main competencies are generally considered as significant in improving sustainable development (de Haan, 2010; Rieckmann, 2012; Wiek, Withycombe & Redman, 2011):

1. Systems thinking competency
2. Anticipatory competency
3. Normative competency
4. Strategic competency
5. Collaboration competency
6. Critical thinking competency
7. Self-awareness competency
8. Integrated problem-solving competency (UNESCO, 2017b, p. 10)

The aforesaid main competencies speak to today’s specific challenges that should be addressed by sustainability citizens. They are pertinent to all SDGs and conjointly can empower people to link the diverse SDGs to each other to see the big picture of the 2030

Agenda for Sustainable Development. Accordingly, it is expected that countries will produce ESD policies that endow learners with the above-mentioned competencies. The next section presents the recent situation in terms of achievements related to ESD in the countries on which this study focuses.

2.2 ESD in Turkey and Germany

While interest in sustainable development has been growing, it is generally agreed that ESD is still in its early stages in Turkey (Alkis, 2008; Haktanır, Güler & Kahriman Öztürk, 2016). As far as producing a comprehensive approach to ESD-related issues is concerned, there is more that Turkey can accomplish. Evidence to support this argument can be found in national implementation reports submitted by Turkey to the UNECE Steering Committee for ESD in 2007, 2010, and 2015 (UNECE, n.d.). While indicating that individual and relevant projects were supported, in those reports, Turkey openly stated that there was no special budget allocated for ESD per se (UNECE, 2016). Within the Ministry of National Education in Turkey, there is no specific department dedicated exclusively to the issue of ESD. The International Organizations Department under the European Union and External Relations Directorate General undertakes the coordination of matters related to ESD. The majority of the research and classroom applications are largely linked to environmental science, mostly framed within a specific disciplinary approach, usually focusing on biology. A similar approach is adopted in the current ECE curriculum in Turkey which has been in force since 2013 and there contains no direct reference to ESD. Issues such as environmental conscientiousness or engagement with nature are covered as part of science activities.

In Germany, there is a high level of political engagement and a clear display of leadership in support of ESD. For instance, having conducted a comprehensive review of ESD research, its deficits and potential, Germany is in an exclusive club of nations (UNECE, 2016). In addition, Germany is also active in initiating regional cooperation attempts to develop ESD policy and practices through networks, involving ESD policymakers and practitioners, such as the Regional Network on ESD, which unites partners from Belgium, France, Germany, and Luxembourg. These network models are being set up in Germany with the main objective of providing support for peer-to-peer learning among educators, as well as chapters of the International Network of Teacher Education Institutions led by the UNESCO Chair in Reorienting Teacher Education toward Sustainability. In order to draw attention to a wide range of ESD support materials, a comprehensive web portal (bne-portal.de) was introduced by the Federal Ministry of Education and Research. Another striking piece of evidence indicating the importance given to ESD by Germany is that the relevant units working in this area are called Provision for the Future, Basic and Sustainability Research (Figure 1).

Section 72 Sustainability, Climate, Energy
Subsection 721 Policy issues sustainability, climate, energy
Subsection 722 Basic Energy research
Subsection 723 Global change
Subsection 724 Resources and sustainability
Subsection 725 System earth

Figure 1. Units working in the field of ESD in Federal Ministry of Education and Research in Germany (Federal Ministry of Education and Research in Germany, n.d.)

It is possible to trace the concrete consequence of adopting this perspective in the ECE curriculum in the form of a separate section for ESD in the Berlin State ECE curriculum (*Berliner Bildungsprogramm*), in which the Germany part of the research is conducted. Teachers are introduced to this concept and encouraged to the provided web portal in order to further increase their knowledge and enhance their abilities in this area.

There are also differences between Turkey and Germany in terms of systems thinking. In this regard, the importance of systems thinking in education has been long recognized in Germany, while the subject has only recently begun to receive attention in Turkey. There are many studies about systems thinking in the field of education in Germany, and moreover, there have been efforts to develop tools for practical applications. For example, within the ESD, a book was prepared for teachers of first to ninth grade students to use to further the children's systems thinking skills (Bollmann-Zuberbühler, Frischknech-Tobler, Kunz, Nagel & Wilhelm Hamiti, 2010). Another example of the implementation of systems thinking is the module named *"Umgang mit Komplexität – Systemisches Lernen"* created jointly by the Ministry of Culture, Youth and Sport and Ministry for Environment, Climate and Energy in Baden-Württemberg (BNE-BW, 2018). In Turkey, it was concluded that although there have been some academic studies in this area, so far only limited progress has been achieved in terms of practical applications.

"The sustainability of the human species can only be defined, ultimately, at the level of the interaction of the entire complex of human systems and all directly implicated environmental system. To understand sustainability therefore requires some understanding of the behavior of systems in general and of human and environmental systems in particular" (Clayton & Radcliffe, 1996, p. 6). The following section of this literature review presents a short summary of the systems thinking history, relationship among systems thinking, sustainability and education.

2.3 Summary of Systems Thinking History

Although M'Pherson (1974) argued that there are some elements of systems thinking in the work of Aristotle[4], this discipline is relatively young (Checkland, 1992), emerging in the twentieth century as a critique of the prevailing reductionism (Flood, 2001). It is agreed that systems thinking has developed from mainly engineering and biology and divided into a number of emphases, methodologies, and applications (Sterling, 2003) as displayed in Ison's 'Influence Diagram' in Figure 2.

The biological roots of the systems field came into being during the 20th century with the attempts of Alexander Bognanov (1913-1917) and Ludvig von Bertalanffy (1956, 1962). *Organised complexity* was noticed in the organisms being studied by biologists in the 1920s. The biologists noticed levels of organization hierarchy, each knottier than the one below it, including features appearing at that level alone and not seen (or having any meaning) at lower levels.

In 1940, Von Bertalanffy differentiated ***open and closed systems***; the latter being entirely autonomous and having no relations with their surroundings, but the former exchanging their setting materials, energy, and information. Closed systems can solely be encountered in the specified abstract class of systems; however, nearly all of the open systems are considered as key for health care professionals and managers.

[4] Aristotle argued that the whole is greater than the sum of its parts.

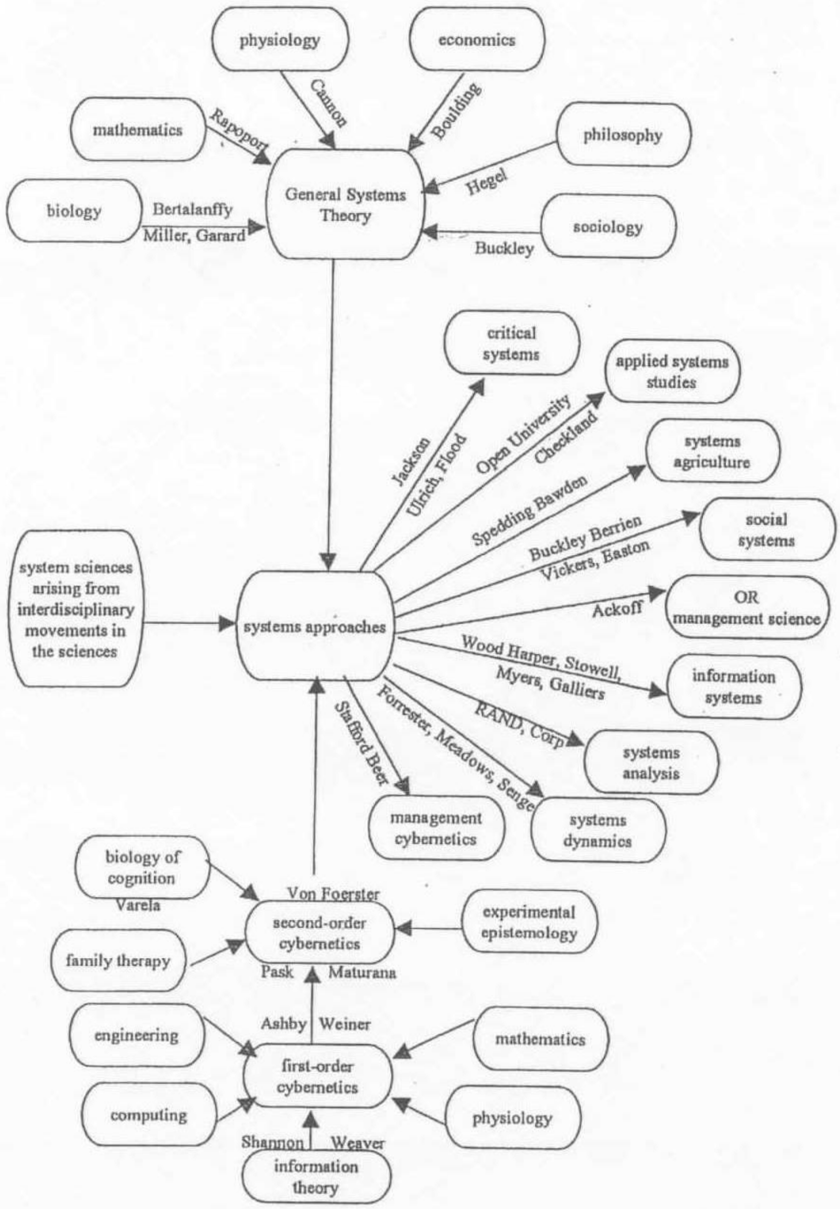

Figure 2. Systems Thinking Influence Diagram (Ison, Maiteny & Carr, 1997)

The other root of the systems field emanated from the engineering discipline. Benefiting principles from control engineering and control theory, in the process of developing the field of cybernetics in the 1940s, Wiener and Bigelow recognized the essential nature and presence of ***feedback.*** Activity within a system is the consequence of the influence of one factor on another, and that influence is labeled as feedback. Wiener and Bigelow stated that there was positive and negative feedback; positive being called enlarging or fortifying feedback and negative being called balancing feedback.

In the 1950s, a group of people from different fields met to establish the Society for the Advancement of ***General Systems Theory***, and systems thinking evolved into an academic subject, gathering a body of knowledge and an academic status. ***Systems Engineering*** developed in the 1950s purported the idea of developing or changing (so *that* sense of engineering) systems. In the early days, the province of engineers was to engage with designated physical systems, but later it began to be applied to human activity systems.

At approximately the same time, the RanD Corporation established ***Systems Analysis*** in the United States, benefiting from the Operational Research expertise that had flourished in the military arena in WW2. System analysis methods, which all demanded the *naming of the system and a defining of its objectives* (Checkland, 1981), and in which the engineer or analyst stands outside the system interfering with it trying to reach a desired aim, started to be known as ***Hard Systems***. This approach "looks at 'how to do it' when 'what to do' is already defined" (Checkland & Scholes, 1990, p. 17).

With Ackoff's powerful study, an amassing apprehension emerged, claiming that the system cannot be often 'named' in a convincing manner in human activity systems, and its targets were often multiple and conflicting during the 1970s. Ackoff presented the term ***mess*** to the management science of the time (1999).

In the 1980s, Checkland developed a methodology for working with ***Soft Systems***, in which the problems are messy, ill-defined, ill structured, and not independent of people, and there may be no agreement about appropriate objectives (Daellenbach, 1994). Later, Checkland (1992) commented, "we are concerned with the attempt to map the concept of wholes onto what we perceive as complex happenings in the real world" (p. 1029). Flood critiqued the soft systems approach stating that it "barely touches upon the notion of knowledge-power and social transformation" (1999, p. 60) and emphasized the role of politics on knowledge.

During the 1970s and 1980s, an increasing interest in the ***modeling*** of systems was seen, sometimes referring to improving hard systems by converting them into soft systems, and sometimes producing novel ways of explaining complex relationships. ***Formulating the mess*** was noted in the same period, in which shaping the system was only the first stage of three. The second stage consisted of a mapping practice in which the large number of factors that prevent the fulfillment of the system's purpose are classified into a small number of divisions. The third stage comprises ‘telling the story’ (Pourdehnad, 1992) and includes “telling a believable and compelling story that reveals the undesirable future implicit in the current state… and leads to a desire for change”.

System Design also debouched in the 1970s and has been further enhanced since then. The notion was established upon the observation that the best way to learn a system is to design it. The process requires the assumption that the system to be replanned has been taken apart overnight, but everything in its environment remains the same.

In the 1980s and 1990s, systems thinking spread, largely by Peter Senge of MIT, making it more available for practicing managers and others. It was integrated into a wider area of study concerning individual and organizational learning, influenced to a great extent by Chris Argyris and David Bohm's study. One of the major endeavors of this study was the designation of ***systems archetypes****;* i.e., influence patterns that can be seen in many different systems.

More recently, an important part of systems scholarship has focused on complexity theory, holistic science, and new theories of living systems (Sterling, 2003). New discussions on the necessity for more participatory worldview especially with respect to sustainability have emerged as one of the subjects in the field (Capra, 1996; 2003). Naturally, criticism has also appeared in the literature, particularly tending toward the field of modeling and cybernetics. According to Gough (1991, 1993), “systems models perpetuate Newton’s ‘world machine’ by reinforcing the view that environmental systems are metaphorically equivalent to mechanical or cybernetic systems”. Wilber (1996, p. 116) accused system theorists of providing another “reductionist nightmare”.

Currently, while there is more endeavor toward the deeper levels of philosophy, there has also been a gradual movement in the field by progressively pointing the ideas of the living systems and the complexity theory, ecological thinking, and practice (Sterling, 2003). “Systemic thinking is not something that can be explained easily and understood comprehensively. It is not recommended to rush into rationalization of this sort… Systemic thinking begins with at intuitive grasp of existence.” Flood (1999, p. 83). Thus, systems thinking is further elaborated in the next section.

2.4 What is Systems Thinking?

According to Senge (1990), the core of the systems thinking discipline is about a shift of mind and Ackoff explained, "Systems is more than just a concept. It is an intellectual way of life, a worldview, a concept of the nature of reality and how to investigate it" (1999, p. 1). Moreover, the "systems view puts forward a more holistic epistemology, ontology and form of action, and coherent relation between them" (Sterling, 2003, p. 104). Furthermore, Senge, Cambron-McCabe, Lucas & Smith (2000) state that systems thinking is "... the ability to understand (and sometimes to predict) interactions and relationships in complex, dynamic systems: the kinds of systems we are surrounded by and embedded in... ST enables you to see the big picture, the minute details that make it up, and the way parts interact over time" (p. 239).

As Arnold and Wade (2015) explained, for certain reasons, the systems thinking skill set has been kept in educational margins and one of those reasons is that there is no common, full definition of systems thinking (Arnold & Wade, 2015; Haines, 2000; Lyneis, 1995; Sterling, 2003). The notion of systems thinking is utilized in various ways which are sometimes contradictory (Stave & Hopper, 2007). In an attempt to overcome this problem, Arnold and Wade (2015) suggested a new definition of systems thinking which combines the relevant literature. Their term was assessed for fidelity against a system test, in which each explanation will be diagnosed to identify whether it includes these three things (Arnold & Wade, 2015, p. 671):

1. Function, purpose, or goal. This case should explain the aim of system thinking in a manner which can be comprehended easily and linked to everyday life.
2. Elements. The characteristics of systems thinking can be shown by these elements.
3. Interconnections. It is the activity elements or characteristics that nourish and connect to each other.

Consequently, they suggested a new explanation for systems thinking by determining its purpose: "Systems thinking is a group of synergistic analytic skills which are utilized to increase the capableness of specifying and comprehending systems, anticipating their behaviors, and inventing modifications to them for generating desired influences. These skills perform as a system together" (Arnold & Wade, 2015, p. 675)

The referents involved in the explanation are themselves determined as the following:

- Systems: Sets or assemblages of interconnected, mutually dependent, or interacting components, which establish joint entities.
- Synergistic: Typical of synergy, this is the interaction of components in a pattern that, generate a total influence, which is bigger than the sum of the specific components, when united.
- Analytical skills: The skills that supply the competence to imagine, formularize, and figure out both complex and simple problems and perceptions and make logical decisions settled on available information. Those skills involve presentment of the competency to implement logical thinking to collecting and assessing information, mapping and checking solutions to problems, and speculating plans.
- Identify: To cognize the presence of a specific thing.
-Understand: To be closely acquainted with; clearly comprehend the character, characteristics, or subtleties of something.
- Predict: To anticipate as a deductive result.
- Devise modifications: To design, think about or work out differences or improvements.

Then, Arnold and Wade developed the explanation by particularizing upon both its elements and the interconnections between them as shown in Figure 3. The thick lines correspond to strong connections, with the thin dotted lines showing weaker, but still significant links. It should be stressed that the system of systems thinking operates as a cycle of constant feedback loops. Namely, the system constantly operates at the final point. On the contrary, as each of the elements upgrades and advances linked components in turn, systems thinking itself constantly builds up.

The elements shown in Figure 3 were collated from the literature explanations, mainly furnished from Sweeney and Sterman (2000), Hopper and Stave (2008), and Plate (2014). An explanation of all the elements is given below:

1. Recognizing Interconnections:

This is the fundamental level of systems thinking. This skill includes the competency of distinguishing central links between sections of a system. Even highly educated adults without systems thinking education are likely to lack this competency (Plate & Monroe, 2014).

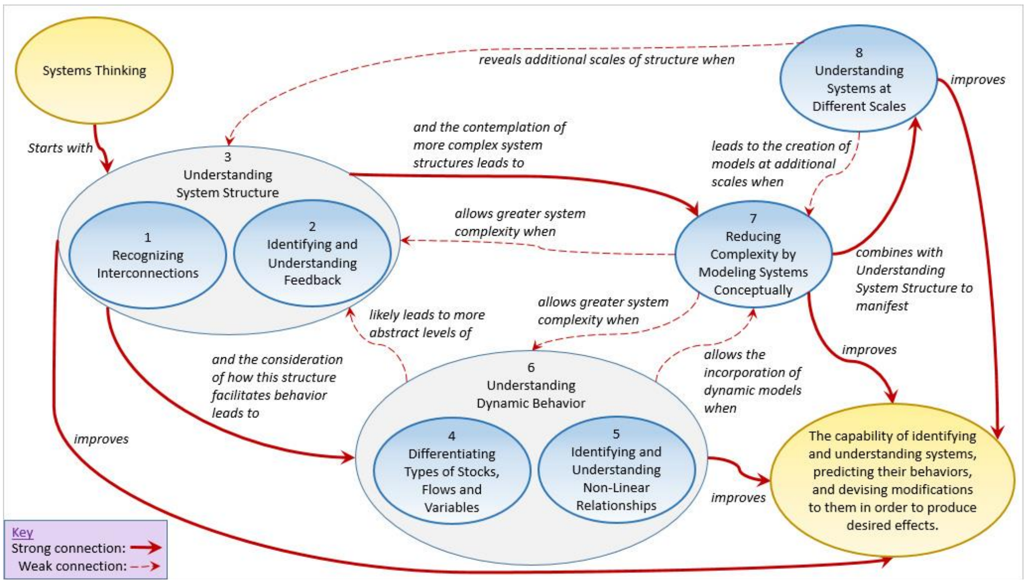

Figure 3. Definition of Systems Thinking According to Arnold and Wade (2015, p.676)

2. Identifying and Understanding Feedback:

Some interconnections unite in order to establish cause-effect response loops (Hopper & Stave, 2008). Systems thinking necessitates determining those response loops and apprehending how they influence system behavior (Plate & Monroe, 2014).

3. Understanding System Structure:

System arrangement comprises components and interconnections between these components. Systems thinking demands comprehending this structure and how it assists system behavior (Ossimitz, 2000; Richmond, 1994). Cognizing interconnections and interpreting response are the tools for grasping system structure. Even though this component is not notably referenced in the taxonomies of Hopper and Stave (2008) or Plate (2014), it can be connoted as a collection of the two aforesaid components and referred to in other significant works (Ossimitz, 2000; Richmond, 1994).

4. Differentiating Types of Stocks, Flows, and Variables:

Stocks point to any group of a resource within a system. This case may be physical, such as the quantity of paint in a bucket, or it can be emotional, such as the level of trust between one friend and another. *Flows* are the level changes. The changeable parts of the system are covariant, which influence stocks and flows, such as the flow rate or the maximum amount of a stock. The capability to demarcate these stocks, flows, and other covariant and cognizing how they run is a critical systems thinking skill.

5. Identifying and Understanding Non-Linear Relationships:

This component symbolizes a deviation from the taxonomies of both Hopper and Stave (2008) and Richard Plate (2014) (Hopper & Stave, 2008; Plate & Monroe, 2014). This component points to stocks and flows of non-linear characteristics. In a conceptual manner, this component is likely to be grouped under Differentiating Types of Stocks, Flows, and Covariant. Nonetheless, the latter is likely to express a linear flow. Non-linear flows are excluded from the components in order to prevent confusion.

6. Understanding Dynamic Behavior:

Interconnections, the way they unite into feedback loops and the manner in which these feedback loops affect and include stocks, flows, and variables establish *dynamic behavior* in a system. This behavior is difficult to comprehend or perceived without systems training (Plate & Monroe, 2014). *Emergent behavior* is a term used to explain unexpected system behavior, which is an example of dynamic behavior. Distinguishing types of stocks, flows, and variables, alongside with determining and perceiving non-linear relationships are both tools for comprehending dynamic behavior.

7. Reducing Complexity by Modeling Systems Conceptually:

This component is the competence of modeling different parts of a system and perceives the system from different perspectives in a conceptual manner. Executing this activity widens the scope of defined system models and is located in the field of intuitive schematization observed as occurring in different ways, like shrinking, transformation, abstraction, and homogenization (Wade, 2011). Perceptual bodies are reported to decrease the conscious accessibility of their parts in the research (Poljac, De-Wit, & Wagemans, 2012). This situation, in a theoretical way, eases the representation of bigger complexity because the mind keeps less detail on each body. This skill can also be perceived as the capability to see a system in different ways which disassemble excess and decrease complexity.

8. Understanding Systems at Different Scales:

This skill resembles Barry Richmond's forest thinking (Plate & Monroe, 2014). It includes the competency of cognizing different scales of systems, and systems of systems.

In this literature review, the definition produced by Arnold and Wade (2015) is considered as the basis because it is based on the research of renowned researchers in the systems thinking field and the terms created by them. The most common and critical systems thinking proficiencies argued in the literature are compounded by the explanation, and this the definition is up-to-date.

In addition, it is considered beneficial to place emphasis on the Systems Thinking Hierarchical Model (STHM) developed by Ben-Zvi-Assaraf and Orion (2009) because this model has emerged from the studies carried out with elementary school children. In this study performed in early childhood education, this model is thought to offer a conceptual framework to explore young children's initial systems thinking skills. Following a comprehensive review of the system thinking literature, Ben-Zvi-Assaraf and Orion (2009) presented a model which shows the eight features of the emergent hierarchic nature of system thinking in the context of earth systems which is shown in Table 5.

Although Ben-Zvi-Assaraf and Orion’s STHM focuses on the earth systems field, it does also brings a general approach to the basic characteristics of systems thinking.

As stated above, systems thinking in education for the sustainability field has been born both to approach sustainability issue with a more comprehensive and holistic way and to develop children who are prepared to meet the global needs of our day. The impact of systems thinking on the education field will be discussed in the next section of this chapter.

Table 5. Systems Thinking Hierarchical Model

ANALYSIS	(1) The ability to identify the components of a system and processes within the system.
SYNTHESIS	(2) The ability to identify simple relationships between or among the system's components. (3) The ability to identify dynamic relationships within the system. (4) The ability to organize the systems' components, processes, and their interactions, within a framework of relationships. (5) The ability to identify cycles of matter and energy within the system—the cyclic nature of systems.
IMPLEMENTATION	(6) The ability to recognize hidden dimensions of the system—to understand natural phenomena through patterns and interrelationships not seen on the surface. (7) The ability to make generalizations—to solve problems based on understanding systems' mechanisms. (8) The ability to think temporally: retrospection and prediction. Understanding that some of the presented interaction within the system took place in the past, while future events may be a result of present interactions.

Source: Ben-Zvi-Assaraf & Orion, 2009, p. 541

2.5 Systems Thinking, Sustainability and Education

Some field researchers argue from the social–ecological frameworks perspective when dealing with sustainability issues, since it is contended that these issues emerge from a sophisticated exchange between natural and socio-political components (Fischer, Gardner & Bennett, 2015). The literature adopting a social–ecological frameworks point of view defend the discussion of the social and environmental frameworks together (Fischer, Hartel & Kuemmerle, 2012) to cultivate sustainability. By embracing a social–ecological systems point of view, Ives, Abson, Wehrden, Dorninger, Klaniecki and Fischer (2018) benefitted from Meadows' concept of leverage points (1999) to investigate cases of how activities to reconnect individuals with nature can offer assistance to change society towards sustainability. According to this conceptualization demonstrated in Figure 4, more externally-defined connections to nature (e.g., material and experiential connections) are more likely to influence system parameters (such as resource stocks and flows), while internally-defined connections (such as philosophical perspectives and emotional responses to nature) are more likely to influence the underlying goals and values embodied in a system.

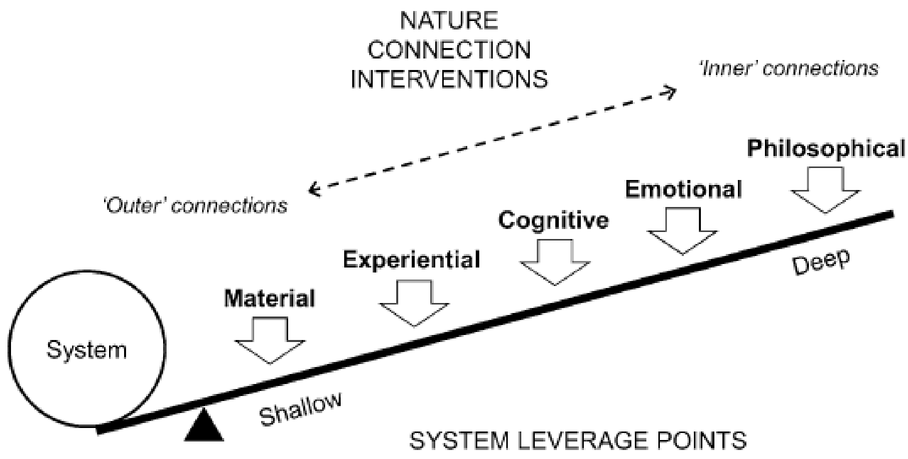

Figure 4. The framing of deep versus shallow leverage points (Ives et al., 2018, p.5)

In a like manner, it is anticipated that mediations that promote an interface between individuals and nature on a cognitively, emotionally and philosophically base have the most noteworthy potential with regard to tending to the numerous environmental and sustainability challenges faced today. In regard to this, the 2030 Agenda (UN, 2015) and the Global Action Programme (GAP) on ESD underlined the significance of education to quicken the advancement towards sustainable development. Reinforcing and reorienting education and learning which targets the acquirement of knowledge, skills, values and attitudes that add to a sustainable future are the most important targets of GAP to be added to the 2030 Agenda.

Systems thinking has become one of the most popular concepts in education due to its potential to suggest new ways of thinking about the complex problems created by the old way of thinking (Nguyen, Graham, Ross, Maani & Bosch, 2012) whether they rest within a local or global context (Bosch, Maani & Smith, 2007; Cabrera, Colosi & Lobdell, 2008). Despite the potential applications of the systems thinking approach being recorded generally by systems scientist and certain academics (Nguyen, Graham, Ross, Maani & Bosch, 2012), there are problems in spreading the understanding of this approach; for example, this term is not in general use (Checkland, 1999); furthermore, it has different definitions (Haines, 2000; Lyneis, 1995) furthermore, the design of formal education consists of isolated parts and fragments rather than systemic relationships (Hannon and Ruth, 2000), and most of the systems education to date has been focused on training specialists (Jones, Bosch, Drack, Horiuchi & Ramage, 2009).

Even though there is a "fashionable call for holistic and systems thinking approaches" (Ulrich, 1993, p. 585), there is no clear definition of the systems approach to sustainability, and thus it does not have practical applications (Porter & Cordoba, 2009). The existence of the multiple languages of systems thinking urged Porter and Cordoba (2009) to provide three distinct approaches to systems and sustainability. After examining the current literature on systems theory, operations research and organization theory, they argued that there are functionalist, interpretative, and complex adaptive systems (CAS) approaches to systems and sustainability.

According to the functionalist perspective, the problem of sustainability can be handled with "the positivist application of reason to empirical observations" (Rihani, 2002, p. 3). Therefore, it is thought that sustainability is an issue of good design and engineering (Bausch, 2001). According to the functionalist sustainability education perspective, the main goal of education should be "the appreciation of the inseparability of the human and natural systems and understanding the importance of the social and cultural aspects of any production arrangement" (Porter & Cordoba, 2009, p. 328). They added that this approach works best when there is a need to explore sustainability within a certain problem which was already defined.

The second perspective of systems theory was influenced by the notion that systems are the mental constructs of the observers rather than entities with an objective existence (Hatch & Yanow, 2003). In this sense, holism and inclusiveness and the idea that the whole cannot be reduced to series of equations because the whole is a greater than its parts entered the scene (Hammond, 2003). According to this approach, the main aim of interpretative inquiry is to understand the mental models, the meaning making systems of the actors, and how the realities of those actors and researchers combine to create shared realities (Hatch & Yanow, 2003). The interpretative approach to sustainability education involves attempts to improve self-understanding, identification of the actors as well as their point of views, and achieving collaboratively made decisions (Porter & Cordoba, 2009).

The third perspective of the systems theory grew out of complexity theory, which has its roots in quantum mechanics (Porter & Cordoba, 2009). As Griffiths (2004) summarized, complex systems consist of thousands of interacting elements, and there is a need for global perspective to understand the interdependent webs of ecological, social and economic environments (Porter & Cordoba, 2009). It is argued that by applying the principles of Complex Adaptive Systems (CAS), students will be able to see the bigger picture and look behind the sustainability phenomena. “Thinking globally, acting locally, but continually reviewing the thinking behind them both, can generate awareness in the students of the benefits and drawbacks of different approaches to sustainability in a world that moves fast and makes history very quickly” (Porter and Cordoba, 2009, p. 342).

Porter and Coroba (2009) emphasized that educators should have a toolkit that contains all the three approaches along with the knowledge of the best use of each. They believe that students’ experience with all of these approaches will lead to the skills to develop solutions to sustainability problems.

Also clarified in the introduction to the current study, system thinking integration into education can still be depicted as limited though it is considered as significant (Jacobson & Wilensky, 2006; Plate, 2010). Bearing this limitation in mind, brief information on the studies carried out by various researchers in the field of systems thinking in education are presented below.

The findings of the study presented in a doctorate thesis executed by Gillmeister (2017) revealed that young children do demonstrate signs of more complex understanding in systems thinking. The purpose of the study was to uncover young children's understanding of systems thinking through everyday kindergarten classroom activities. Twenty students participated in this qualitative study, which utilized read-aloud, water play, and the interpretation and creation of graphs through associated structured and semi-structured interviews. Data from the observations of the students and interviews was transcribed, segmented, coded, and analyzed. As a result of this study, it was concluded that children can utilize some simple systems thinking tools, such as stock-flow maps, feedback loops, and behavior-over-time graphs.

A master’s thesis on the subject of systems thinking in early childhood education for sustainability was conducted by Åkerman (2012). The aim of this thesis was to investigate how young children’s narration of an everyday object, the meatball, could be used as a tool for systems thinking and education for sustainable development in early childhood education. A case study research method based on narrative inquiry was utilized in this study. The findings of the study revealed that humans were largely missing from the children’s social-ecological system, additionally a difference in the approach of acknowledging uncertainty vs. imaginary explanations to phenomena surrounding a meatball was found.

Systems thinking and systems dynamics in various classroom settings were the focus of some research. Fourteen studies on systems thinking interventions in the classroom environment, from kindergarten to the postgraduate level were categorized by Hopper and Stave (2008). One study concerning knowledge of systems interventions in the classroom based on anecdotal records was found (Skaza & Stave, 2010). It was briefly noted that students’ ability to comprehend the dynamic behavior and their competency to describe different variable and flows were the main topic of the research in most cases (Hopper & Stave, 2008). In reference to Stave and Hopper’s systems taxonomy (2007), those skills exist at intermediate level, and only few practices scrutinized the lower level skills of the systems thinking taxonomy.

‘Systems Thinking in Schools Project’ by the Waters Foundation Project has been implemented in schools via working with students, and it was detected that systems thinking tools and habits offer many opportunities to boost decision-making and critical thinking skills of children from kindergarten to the 12th grade (Yates & Davidson, n.d.). The Systems Thinking in Schools Project aims to raise the capacity of K-12 educators to transfer academic and lifespan benefits to students via systems thinking and dynamic modeling concepts, habits, and tools.

In a study implemented by Danish, Peppler and Phelps (2011), BeeSign simulation software was established to aid young children in learning about honeybees collecting nectar and was employed from a complex systems perspective. This study is the first of its kind to implement an existing complex systems framework (SBF) to explore young students’ apprehension, and the outcomes point to these students could, in fact, explore complex systems in detail. Current research with BeeSign also exhibits that students can proceed to see and debate rich patterns in honeybee behavior in consequence of these interface choices.

Evagorou, Korfiatis, Nicolaou and Constantinou exploited another systems thinking approach in K-12 through a simulation (2009). This study aimed to explore the impact of a simulation-based learning environment on the development of system thinking skills of elementary school students (11–12 years old). Interactive simulations which use the Stagecast Creator software in order to simulate a marsh ecosystem were included in the learning setting (over a period of five 90-min lessons). Two written tests were applied to the students exploring the development of seven aspects of system thinking before utilizing the learning environment. Identical tests were executed after the practice. More particularly, four of the tasks covered in each test were connected with skills regarding a system's structure and elements, and three were related to the processes and interactions recurring within a system. According to the findings, elementary school students have the potential to develop system thinking skills. The suggested learning environment instigated a respectable betterment in some system thinking skills during a comparatively short learning process.

Ben-Zvi Assaraf and Orion (2010b) addressed the development of system thinking skills at elementary school level. Their work raises the question whether elementary school students can cope with complex systems. The sample comprised 40 students in fourth grade from one school in a small town in Israel. The students followed an inquiry-based earth systems curriculum centered the hydro-cycle. Laboratory simulations and tests, direct interaction with factors and processes of the water cycle in the outdoor learning surroundings, and knowledge consolidation activities were included in the program. The researchers commented that most of the students made important progress in their ability to classify the hydrological earth system into its elements and processes despite the minimal initial system thinking abilities of the students. The students were able to recognize interconnections between the elements of a system. Some students attained higher system thinking abilities, such as separating interrelationships among several earth systems and distinguishing the hidden parts of the hydrological system. These students could form a concrete local water cycle, which may later be broadened to a large scale abstract global cycles due to the direct contact with real phenomena and periods in small scaled scenarios. The fourth-grade students' capacity to develop basic system thinking skills at their young age was been enhanced by the integration of the learning based on outdoor exploration with activities based on laboratory exploration and knowledge incorporation assignments. This case proposed that although system thinking is considered as a thinking skill of high order, it can, to a certain extent, be improved in elementary school. These abilities can prepare the ground for the advancement of higher phases of system thinking at the junior–high/middle school level with an appropriate long-run curriculum.

A study conducted in New Zealand (Hipkins, Bull & Joyce, 2008) was executed to gather 25 children’s (ages 10-12) ideas after they had taken part in a Waterways project. Following a method described by Ben-Zvi-Assaraf and Orion (2005), the analysis revealed mismatches between children’s conceptual understanding and their familiarity with (ability to describe in words or images) the context of the waterway.

The results of the study administered to middle school students signaled that some students had difficulties with regard to comprehending the basic characteristics of the systems thinking (Ben-Zvi-Assaraf & Orion, 2005a, 2005b). Young students are the group that most easily comprehend visible characteristics of systems thinking and the structure of this concept (Hmelo-Silver & Pfeffer, 2004). Systems thinking skills are also claimed to provide trustworthy tools in order to comprehend the complex relations in the natural and social world (Maani& Maharraj, 2004). Although most researchers underline the significance of the detailing of systems thinking abilities, particularly by means of science-related perception, it is postulated that particularly for younger students, the sources for teaching system thinking skills are narrow within science (Evagorou, Korfiatis, Nicolaou and Constantinou, 2009). It is postulated by Evagorou et al. (2009) that particularly within the current educational perspective, complex systems learning is a hard task. This assertion has also been indorsed in the literature by many studies (National Research Council, 2000; Penner, 2000; Sheehy, Wylie, McGuinness & Orchard, 2000).

LaVigne (2009) reiterated the attempt of the Massachusetts Institute of Technology (MIT) to cooperate with different schools with regard to the commencement of systems thinking in schools and implementation of systems dynamics modeling software in K-12 classrooms. Four types of evidence (anecdotal records, action research, student surveys, and empirical study) were displayed in order to show the effect of systems thinking/dynamic modeling methodologies on student learning. In terms of anecdotal records, visual learning tools mixed with distinct experiential learning possibilities positively influenced the student understanding. Additionally, teachers' descriptions accentuated the students' ability to link the learning in the classroom to real-life situations. It is widely claimed that schools' stories demonstrated the positive effect of visual nature of systems thinking strategies in terms of establishing the learning of students about communicating and forming their thinking over 20 years. Some of the teachers had the opportunity to complete projects on action research in order to evaluate the performance level of a student before and after utilizing special systems strategies as a part of the instruction. The meta-analysis of those action research projects has formed the basis for the trends below (LaVigne, 2009, p. 4):

- Students utilize systems thinking instruments to crystallize and visually display their apprehension of complex systems. This visual perspective assists the students and others to interact with, and discover thoughts, insights, and mental models in a precise and clear way.
- Systems thinking instruments assist students to make links between curricular fields and related life experiences.
- Systems thinking problem-solving strategies are learned, and utilized by students of all ages in an independent manner.
- When benefiting from systems thinking notions and instruments, many students displayed amassed motivation, engagement, and self-esteem.
- Systems thinking abstracts and instruments assist students in evolving as readers and writers.

An empirical research project was implemented by Plate (2006) within schools, aided via Systems Thinking in Schools applied by the Waters Foundation Project. The research entitled "Assessing the effectiveness of systems-oriented instruction for preparing students to understand complexity" had a goal to compare the behaviors of the group that used ST tools (the systems group) with the group that did not use these tools (control group). Plate (2006) discovered that the systems groups were able to acquire causal maps that were "on average, more similar to expert maps than those of their respective control groups" (p. 177). Plate made the comparison of the maps based on certain criteria which involve identifying the key variables and the appearance of feedback loops utilizing a scoring rubric. In two studies, both the systems group and the expert groups had more similar scores than the respective control groups. Plate deducted that the systems groups demonstrated that they understood the situation greater than the control groups. Though the differences observed are not sufficiently specific to postulate strong claims on systems-oriented instruction only established on these studies, they are powerful enough to guarantee further studies evaluating the worth of systems-oriented instruction as a pedagogical tool (Plate, 2006).

Brandstädter, Harms and Großschedl (2012) proposed the utilization of concept-mapping (CM) as a sufficient instrument for evaluating students' system thinking in the article named “Assessing System Thinking Through Different Concept-Mapping Practices”. This study aimed to diagnose whether certain features of CM practices influence the valid evaluation of students' system thinking. The medium (computer versus paper–pencil) and the directedness (highly directed versus non-directed) of CM practices were the specific features that were evaluated. 154 German fourth graders (mean age: 9.95 years) and 93 eighth graders (mean age: 14.07 years) participated in the study after an experimental pre-test–post-test layout. The findings demonstrated that student performance in CM was positively influenced by the computer when compared with paper–pencil. However, highly directed and non-directed mapping showed no difference between the groups. While the medium seldom affected the validity of CM for system thinking, high directedness displayed a positive effect. Thinking about the disadvantages and advantages of specific CM practices, they proposed highly directed and computer-based CM as a suitable evaluation tool, especially in terms of large-scale evaluations of system thinking.

In a study conducted with 7- to 10-year-old children in rural Colombia (n = 22), the aim was to enhance the systems thinking skills of children by the construction of a rain water recollection system and organic vegetable garden (Witjes, Muñoz-Specht & Montoya-Rodríguez, 2006). Children from urban settings were included in the study as members of the control group. The children in the experimental group were presented with three different drawings and interpretation of drawings in terms of the following three systems thinking levels were made: (1) systems, subsystems and synergy, (2) possessiveness and feedback, and (3) chaos and order. Overall, the systems thinking level of all children were categorized medium to low according to those systems thinking levels presented before.

As a result of the current literature review, it was concluded that despite the common acceptance of the importance of systems thinking, studies exploring young children’s nature on demonstrating systems thinking skills are very rare. After all, systems thinking has only recently been receiving the attention of the academic community in Turkey. Moreover, studies concentrating the relationship between the systems thinking skills of preschool children and educational contexts were not available in the accessible literature. Therefore, as one of the first attempts to conceptualize young children's systems thinking skills as well as identifying key educational contextual variables effecting those skills, this study aimed to fill the gap in the field of systems thinking in early childhood education and ECEfS literature. Based on this aim, this study explored the characteristics of the young children's systems thinking skills and the impact of educational contexts including the ECE systems at country, preschool and learning group levels on those skills.

CHAPTER 3

METHOD

In this part of the research, firstly, the research design, unit of analysis/case selection as well as participants' selection procedures will be introduced. Secondly, data collection procedures including information about the researchers, data collection instruments, and details about the panel review and pilot application will be presented. Lastly, limitations of the study, data analysis procedures and strategies to establish trustworthiness will be explained.

3.1 Research Design

This study employed a multiple case study design to understand how systems thinking skills of 4- to 6-year-old preschool children can be conceptualized across different preschool contexts in Turkey and Germany as well as how those educational contexts influence the construction of this particular skill. There are five main reasons why this research utilized a multiple case study design. First, a case study is a type of empirical inquiry that explores current phenomena (in this research, this is systems thinking skills of preschoolers) in their real-life context (in this research, preschool group contexts), particularly when it is difficult to separate the phenomena and context (Yin, 1994). Secondly, case studies stimulate interest as a means of furthering the investigation that leads to explanation of what and why something happens and thus increases applicability (Merriam, 1998). This is the most suitable method for the current study due to the case study method being driven by descriptive research, which is mainly interested in gaining an insight about the interaction between the participants and an educational context as well as the impact on different outcomes. Furthermore, if the main focus of the research is to inquire how and why, then a case study is the preferred approach, when contemporary events in a real-life context occupy central roles and they offer an "opportunity for a holistic view of a process" (Patton & Appelbaum, 2003, p.63). Fourthly, given the goal of the proposed study to describe what happened under certain conditions, which necessitates collecting data in natural settings involving a small group of participants (e.g., classrooms), a case study method is the method best suited for the current research. Finally, in the multiple case study approach, there are various advantages of having the opportunity of the independent investigation of a phenomenon. In the current research, this refers to systems within an in-depth examination of a site (in this case, a preschool group) and an examination of the phenomenon across various settings (in this case, preschools). Multi-case studies allow for the evaluation of each case independently as well as across cases to observe whether participants behave differently in a different setting or when conditions have changed for specific tasks (Bloomberg & Volpe, 2012; Stake, 2006). In this way, case study research aims to reveal the possibilities of a holistic and contextual comprehension of a phenomenon of interest based on multiple sources of evidence, instead of a study of specific variables relying on single data sources (Yin, 2009). By using replication logic, this approach involves each individual site feeding both the questions and understanding of ensuing sites. In this fashion, multiple case study results are generally considered more robust in comparison to those employing a single case design (West & Oldfather, 1995; Yin, 1994). Accordingly, the researcher of this study decided that the multi-case study would better capture the variability of children's skills than single case studies and enhance the generalizability of the research findings (Yin, 2009).

During the study, the premise that realities are multiply constructed was accepted as implied in naturalistic inquiry (Lincoln & Guba, 1985). In a naturalistic study, the research setting cannot be manipulated by the investigator. Instead, what matters for the investigator is to study the events as they occur in their natural environment. Qualitative data such as detailed descriptions of situations, people and interactions, quotations of people about their thoughts and experiences, as well as extracts from documents or records obtained through this type of research reveal depth and detail (Patton, 1980). According to Wilson (1977), two perspectives bear particular significance in providing a rationale for gathering data in a naturalistic setting: (a) The context in which the human behavior occurs influences it in a complex way. There is an inherent risk that if a research plan takes the actors out of the naturalistic setting, it may obscure its own understanding by hindering those forces. (b) There is more depth in human behavior than is often initially perceived. In order to understand behavior, a researcher must determine the manifest and latent meanings for the participants, and also understand their behavior from a perspective outside the objective (p. 253). Thus, the researcher examined the existing research by developing different instruments prior entering the sites, but also allowed for inevitable changes in direction of the inquiry with variance in research sites, participants, and interactions among them.

Case studies can be categorized according to goals which can be descriptive, explanatory or exploratory (Stake, 1995). The study presented here is intended to be a theoretical exploration, though there are components of description and explanation. While engaging this process, the researcher has borne in mind that the case study methodology has had numerous critics (Corcoran, Walker & Wals 2004; Flyvbjerg, 2006; Dillon & Reid 2004; Kyburz-Graber, 2004). This method is mostly being rebuked for the lack of trustworthiness of the data (Bryar, 2000; Hamel, Dufour & Fortin, 1993; Pegram, 2000; Zucker, 2001). Precautions have been taken and are detailed in the section of "Establishing Trustworthiness"; however, it is useful to consider the most basic criticisms of this methodology. The case study approach is mostly criticized for the absence of generality based on the general conceptualization which stresses, "general, theoretical (context-independent) knowledge is more precious than concrete, practical (context-dependent) knowledge" (Flyvbjerg, 2006, p. 221). Case studies are believed to provide context-dependent knowledge and experience. As Flyvbjerg elaborately clarified in his paper entitled "Five Misunderstandings About Case-Study Research", the similarity of the case study to real-life scenes and its multiple abundance of details are essential for researchers for two reasons. Firstly, it is significant for the progress of a refined reality sight, which refers to the belief that human behavior cannot be embraced in a meaningful manner as simply as it is envisaged in a hypothesis. Social sciences have failed to generate general, context-independent theory and therefore they have nothing to provide apart from concrete, context-dependent knowledge. The case study is particularly well fitted to generate this knowledge. Secondly, cases are significant for researchers to develop their skills required for undertaking good research in their own learning processes.

The second common criticism concerning the use of case studies relies heavily on the first criticism and is related to the power of generalization in a case study. It is mostly agreed that a few cases do not constitute the basis for generalization. However, as Flyvbjerg (2006) comments, this basis relies on the case that is mentioned and how it has been selected. The situation also applies to the natural sciences as well as research into human affairs (see also Platt 1992; Ragin and Becker 1992). The meticulously selected experiments, cases, and experience also distinguished the development of the physics of Newton, Einstein, and Bohr, and the case study method had a fundamental role in the works of Darwin, Marx, and Freud. In social science, choosing a case in a strategic manner can greatly contribute to the generalizability of a case study. In the following chapters pertaining to the current study, detailed information concerning the participants, unit analysis and case selection will be provided.

3.2 Unit of Analysis/Case Selection

As stated by Tellis (1997), deciding on the unit of analysis is one of the critical issues in a case study. In this study, a system of action, namely a preschool group was chosen as the unit of analysis since the literature suggests that educational contexts influence the higher order thinking skills of children (Greenberg, 2018; Hung, 2008), and systems thinking is one of these higher order thinking skills (Thornton, Gary Peltier & Perreault (2004). During the collection of data, interaction within a preschool learning group and with other preschool components such as the teacher, the preschool administrator, physical environment and supervised activities were carefully examined in order to maximize the understanding of preschoolers' systems thinking skills while "preserving multiple realities" (Stake, 1995, p. 12). The logic underlying the use of a multiple-case approach in this study was to explore how contrasting educational contexts affect the construction of young children's systems thinking skills. Thus, the cases in this study were selected to produce contrasting results but for predictable reasons (a theoretical replication) (Lee, 2006). To this end, both for exploratory and comparative purposes, four cases were selected as the unit of analysis in the study. After the researcher visited the four case sites, the data was collected in the targeted format and a general review of the data was made. Then, it was decided that data should be collected from the other learning group in the preschool in order to provide rich and in-depth data. This decision was made because an emergent, flexible, and responsive design of a qualitative study is needed to respond to the changing conditions of the study (Tomlinson, Gould, Schroth & Jarvis, 2006). The addition of another case to the study aimed to reveal the context-sensitive features and engage in a closer observation of this preschool, since the most qualified work was performed with other learning groups in the preschool in terms of systems thinking. Thus, there were five cases were included in the study, which are presented in in the Figure 5 which demonstrates the research design of the study.

During the data collection, the researcher of this study closely collaborated with two preschool groups in Turkey and three preschool groups in Germany. The four cases in the original research design were selected according to the socio-economic family background of the children and the pedagogical concept of the preschool. These four cases were selected from four preschools attended by children of university-educated families of medium socio-economic status (SES). The fifth case was included later in the study. This preschool in Germany provided the richest and most in-depth data.

The case selection process emerged from the review of literature as well as the work experience of the researcher. As Patton (1990) stated, purposeful sampling is a method that directs the researcher to select information-rich cases that are suitable for an in-depth study. Patton further explains information-rich cases as the cases in which the researcher "…can learn a great deal about issues of central importance to the purpose of the research" (p. 169). Achieving the two basic goals is the aim of performing purposeful sampling within the scope of the research. For the first goal, it was decided to choose learning groups from the learning environments that reflect the general characteristics; that is, the 'prototypical value' of the mainstream preschools in which children of medium SES families attend. For the second goal, learning groups in alternative education preschools that can be considered as compatible with the ESD approach which is likely to support systems thinking were selected, since systems thinking is perceived as an essential part of schooling for sustainability (Center for Ecoliteracy, n.d.). Consequently, the aim of the sampling that was performed in the current research was to compare and contrast the effect of different pedagogical approaches on the systems thinking skills of young children. The two preschool groups are defined below:

The Mainstream Preschool Learning Group (the Case): This term describes the preschool groups that closely follow the Ministry of National Education Early Childhood Education Program (2013) conceived centrally in Turkey, and the *Berliner Bildungsprogram* in Germany constructed federatively by the Berlin Federal Ministry of Education[5]. No alternative perspective is applied in the school in generating the structure and learning experience of the preschool education.

The Alternative Preschool Learning Group (the Case): This term refers to the preschool groups that follow the Ministry of National Education Preschool Education Program in Turkey and the *Berliner Bildungsprogram* in Germany; however, the components of the preschool and learning experiences have been designed in accordance with the principles of ESD with an alternative and sometimes critical view of the traditional curriculum.

[5] Details of Turkish and German ECE curriculum can be find in the findings section.

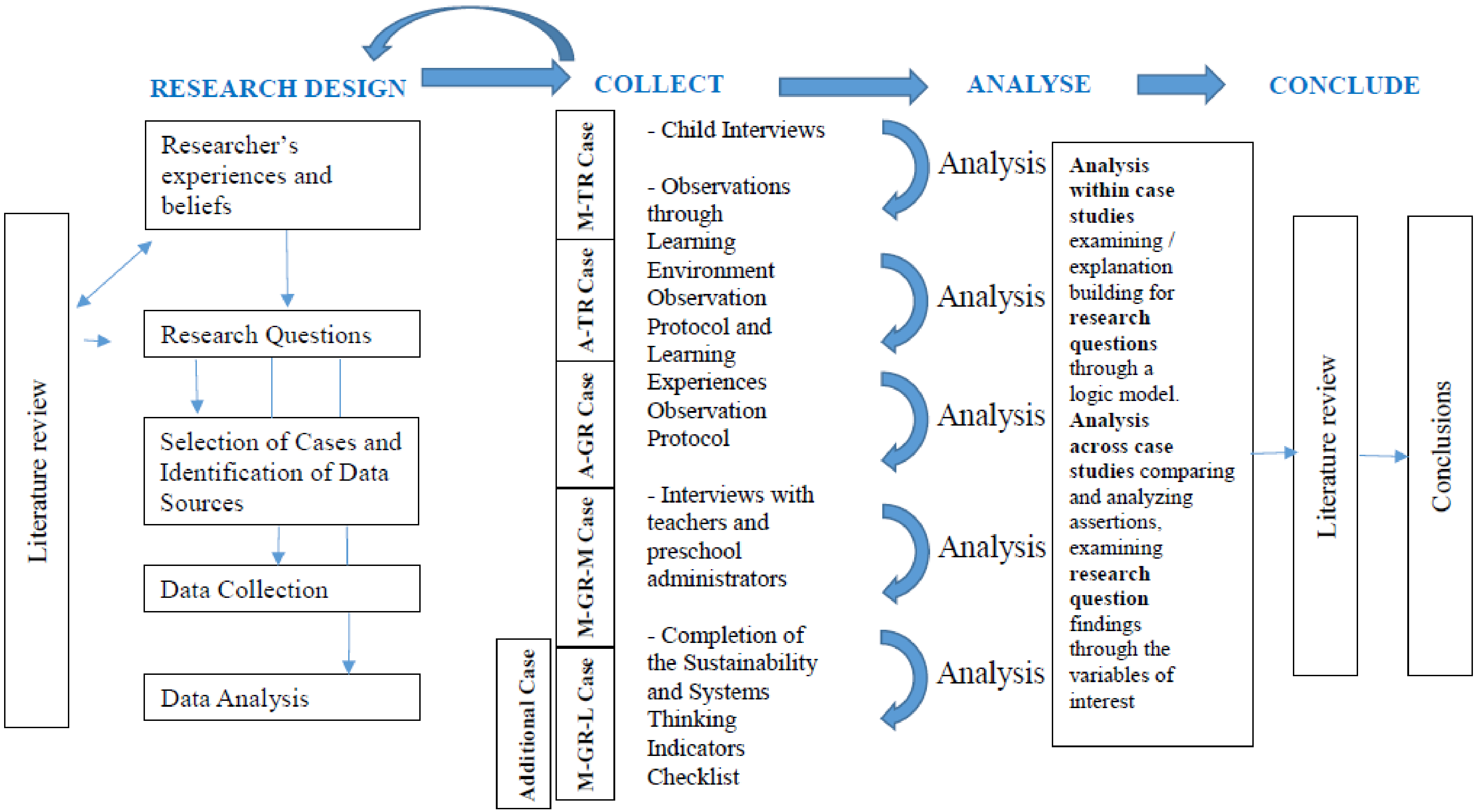

Figure 5 . Research design

Convenience and purposeful sampling methods were used to identify and recruit the child and adult participants in selected cases. During convenience sampling efforts were made by the researcher to ensure that geographical locations of the learning groups were easily accessible. The sampling strategy of the research is further detailed below:

Convenience sampling in Turkey: The researcher contacted five different mainstream preschools. These candidate schools were all located in Istanbul city on the basis that the researcher is familiar with the conditions of this city. A preschool located in the Levent district attended by children of university-educated families agreed to take part in this study.

Convenience sampling in Germany: Since the researcher was living in Berlin at the time the study was conducted, she was able to access mainstream German preschools. The main researcher and her native German speaking partner contacted around 30 different mainstream German preschools to ask if they would agree to being involved in the research. A preschool regularly attended by children of high school and university educated families located in the Schöneberg district in Berlin agreed to take part in the study.

According to Cohen, Manion and Morrison (2000), purposeful sampling is a procedure executed for a specific purpose and involves selecting a group that fits a preset profile. In this study, purposeful sampling (Patton, 1990) was used to identify child participants from a specific family background within two educational approaches; namely, mainstream and alternative preschool learning groups in which children of at least high school graduate families were accepted in this study.

Purposeful sampling in Turkey: Preschools considered to be the most suitable within the scope of the study in terms of the pedagogic approach to predefined mainstream and alternative preschool compatible with ESD concepts were contacted. There was no problem in accessing suitable mainstream preschools but extensive research had to be undertaken to find an ESD preschool. In Turkey, there is a limited number of preschools that comprehend ESD principles and apply them to children's learning experiences. Finally, two institutions that apply ESD principles into their education and training mentality were contacted. An ESD preschool located in Izmir attended by children whose parents mostly had a higher education level agreed to take part in the study.

Purposeful sampling in Germany: Seven preschools that operate under the Studentenwerk Group[6] were contacted since they positioned themselves as under the *Berliner Bildungsprogram* in Germany and used the ESD concept as the basis of their educational approach. A preschool located in Karlshorst agreed to participate in the study. Details of the sampling strategy of the research are shown in Table 6.

Table 6. Sampling strategy of the research

<table>
<tr><td><u>Alternative Education Preschool in Turkey (the Context)</u>

Preschool Group:
A-TR Case</td><td colspan="2"><u>Alternative Education Preschool in Germany (the Context)</u>

Preschool Group: A-GR Case</td></tr>
<tr><td><u>Mainstream Education Preschool in Turkey (the Context)</u>

Preschool Group:
M-TR Case</td><td><u>Mainstream Education Preschool in Germany (the Context)</u>

Preschool Group (children of university educated families):
M-GR-M case</td><td><u>Mainstream Education Preschool in Germany (the Context)</u>

Preschool Group (children of mostly high-school educated families):
M-GR-L case</td></tr>
</table>

Unit of Analysis: Preschool group (*Vorschulegruppe, Anasınıfı öğrencileri*)

3.2.1 Selection of the Participants

The choice of the child participants in thte cases was undertaken on the basis of the literature. As explained in Chapter 1, there is a widespread opinion in the literature that children are natural systems thinkers. Preschool groups with children aged 4, 5, and 6 were included in the study to further explore this statement. In addition to children participants, adult participants were also included in the study. In this context, interviews were conducted with the preschool administrators and the most senior teachers who were assigned to each of the cases to unfold the details of the educational contextual issues of the cases.

[6] Studentenwerk Group works as a partner with different universities and was mainly established to provide educational services usually for the children of parents who are students or lecturers at the universities.

3.3 Data Collection

In this part of the study, data collection procedures including the data collection instruments, panel review and pilot application and information about the researchers are presented.

3.3.1 Data Collection Instruments

A case study is considered to be a triangulated research strategy. The need for triangulation arises from the ethical need to confirm the validity of the processes. In case studies, this can be achieved by using multiple sources of data (Yin, 1994). Indeed, the case study's strength relies on "its ability to deal with a full variety of evidence—documents, artifacts, interviews, and observations" (Yin, 2003, p. 8). Empirically, this doctoral research project drew on ten main sources of data which is categorized according to the research questions as can be seen in Table 7.

Table 7. Data collection and analysis strategy

Research Questions	**Participants**	**Analysis Method**	**Instruments**
1. What are the levels of systems thinking skills of 4- to 6-year-old preschool children in Turkey and Germany?	Children	Constant Comparative Analysis	• The child story entitled as “The Water Hole” written and illustrated by Graeme Base • Child Interview Protocol based on the above-mentioned story • Systems Thinking Developmental Rubric for K-Level
1. 1 How do systems thinking skills levels of 4- to 6-year-old preschool children in Turkey and Germany change according to age, gender, language background and parental education level?	Children	Descriptive Statistics	• Score distribution sheets

Table 7 cont. Data collection and analysis strategy

2. What are the interaction patterns among aspects of systems thinking skills and Turkish and German educational contexts? 2.1 What are the key variables that define the interaction patterns among systems thinking skills levels of 4- to 6-year-old preschool children and educational contexts in Turkey and Germany for developing ESD educational policies and classroom applications?	- Teachers - Preschool Administrators - Children	Content Analysis	"Instrument-based Sustainability and Systems Thinking Indicators List" and "Sustainability and Systems Thinking Indicators Checklist" which are based on the data collected through: • Learning Environment Observation Protocol • Learning Experiences Observation Protocol • Teacher Interview Protocol • Administrator Interview Protocol • Field Notes and Reflexive Journals • Additional Documents
3.1. What are the levels of systems thinking skills of 4- to 6-year-old preschool children across mainstream and alternative cases from Turkey and Germany? 3.2. What are the characteristics of the educational contexts of mainstream and alternative cases from Turkey and Germany? 3. 3. What are the similarities and differences within; 3.3.1 mainstream and alternative education cases from Turkey vs. mainstream and alternative education cases from Germany? 3.3.2 mainstream education case from Turkey vs. mainstream education cases from Germany? 3.3.3 alternative education case from Turkey vs. alternative education case from Germany?	- Teachers - Preschool Administrators - Children	Cross-Case Analysis Within and Across Cases	Cross-case analysis will be done through utilization of the all instruments

Some items in the Sustainability and Systems Thinking Indicators Checklist were obtained from earlier studies and adapted to this study. Remaining instruments were prepared by the researcher by drawing upon the relevant literature. Panel reviews and pilot studies were performed after this preparation. After preparing the final Turkish version of these instruments, they were professionally translated into German. Following the translation process, a back translation by a German and Turkish native speaker was undertaken to ensure that both language versions were identical. In the last stage before instruments were activated in the field, the German research partner reviewed the content for the final time. At this stage, in particular, the cultural and educational appropriateness of instrument contents were checked. Field notes and reflexive journals were also included into the study by taking remarkable notes penned by researchers and partners during and after the observations. The item 'additional documents' refers to the documents that were analyzed to better understand and define the conceptual and contextual characteristic of the cases, and also included the documents of the preschools introducing the concept and themselves. Details regarding the instruments are presented in the next section.

3.3.1.1 Child Story, Child Interview Protocol and Systems Thinking Developmental Rubric for K-Level

As Stake explained, "the interview is the main road to multiple realities" (1995, p. 64). Biklen (1992) added that in this way, researchers can conceptualize the other's understanding of the environment that might include feelings, insights, experiences, judgments, thoughts, and intentions. LeCompte and Schensul (1999) further pointed out that "interviews follow the format of the formative theoretical framework and explore the main domains in the study, initial hypotheses, and contextual factors related to the study" (p. 123). It is important that the researcher elicits facts, opinions, and insights about specific occurrences. This must be undertaken remembering that "when the interviewer controls the content too rigidly, when the subject cannot tell his or her story personally in his or her own words, the interview falls out of the qualitative range" (Biklen, 1992, p. 97).

The investigator of this research conceptualized, planned and administered an individual story reading session with the child participants to explore the details of their systems thinking skills. Choosing a children's story as a research tool is justified in the following extracts from the reviews of Linda Booth Sweeney's book, "When a Butterfly Sneezes" (2001):

“Systems thinking and stories are both valuable ways of understanding relationships among the seemingly disconnected parts of our experience.” Stone Wiske, Director of the Educational Technology Center, Harvard Graduate School of Education.

“It is obvious by now that facts and figures are not enough to prepare us for this rapidly changing world. We need the tools and imagination to see relationships between things, and to see the ways they interact to shape our lives and our society.” Joanna Macy, Author. In her review, Joanna Macy explains that stories are very good guides which train the imagination of children while being good sources of detecting and demonstrating the principles of systems.

“All the world’s ethical traditions have their roots in stories. Archetypal stories teach us to see the world in unique ways-as an independent system where today’s gains may presage tomorrow’s disappointments, where doing what makes sense for me may eventually make everything worse for us. Many ethical failings of our world today rest in the declining role of such stories in raising our children” Peter Senge, Author.

Linda Booth Sweeney explains her point of view in her abovementioned book as:
“Through systems thinking examples and stories, we can show our children how to solve, anticipate, or as systems thinker Russell Ackoff says, “dissolve” problems. We can also show them how to address challenges facing them in their communities and the world. Systems thinking can help a child to understand how the mysterious natural and social worlds function, see how he or she contributes to trouble or create success…” (p. 15).

The child interview protocol was administered parallel with the fiction child story titled "The Water Hole" written and illustrated by Graeme Base (2001). The members of the review panel considered this to be a “developmentally appropriate story” for the target children group of the study. Throughout the story and at the end of the story, to explore the nature of young children’s systems thinking skills, the children were asked about 19 questions directly related with the characteristics of systems thinking skills (Sample questions received from the child interview protocol are provided in Table 8 and the text of the story together with the child interview protocol is provided in Appendix A). The child interview questions were mainly derived from Sweeney’s book (2001), the studies of Ben-Zvi-Assaraf and Orion (2005a, 2005b, 2010a, 2010b) and the Waters Foundation’s applications in early childhood settings (Benson, LaVigne & Marlin, 2015). In addition, a few questions were prepared by the investigator.

The Water Hole book combines counting, geography, environment and art to tell the story of diminishing water in countries around the globe. The book starts with the following explanation appeared on the first page: Down to the secret waterhole the animals all come. As seasons bring forth drought and flood, they gather there as one. United in their common need, their numbers swell to ten. Successive spreads introduce a growing number of animals (from one rhino to 10 kangaroos) at a water hole which, as viewed through die-cut ovals of progressively decreasing size, becomes smaller with each turn of the page (Figure 6 and 7). So, in the beginning the water is prevelant but as the animals drink the water starts to deplete. When the water runs out the animals go away. Then a rain storm comes and replenishes the supply so the animals can return.

Figure 6. Two tigers drinking from the water hole

Figure 7. Four snow leopards looking at the smaller water hole

The Waters Foundation (2016), which aims to increase the capacity of educators through the effective application of systems thinking strategies in classroom instruction and school improvement, also strongly emphasizes that children's literature illustrates potential connections to systems thinking concepts, habits, and tools. Graeme Base's "The Water Hole" story has been mentioned in different sources. The Waters Foundation evaluated this story as archetypal in embedding different systems thinking components and characteristics. Aforementioned story was designed on the Limits to Growth Archetype. According to this systems archetype (Figure 8), growth processes are naturally inherent limits to growth. It is important to identify these limits to avoid problems in future, whether the problem is overpopulation (growing number of the animal population), increasing demand for a water (consumption patterns) or an unfair distribution of the water (previous comers consume more, latecomers consume less). When growth is desired but limited, it is always better to find ways to increase the limit before pushing for more growth. This means that there should be an understanding among animals that there is a limit to growth and something should be done before all the water has been used. Excessive growth in the face of a limit often leads to collapse (deserting and abandonment) as it was the case in the story that was read to the children.

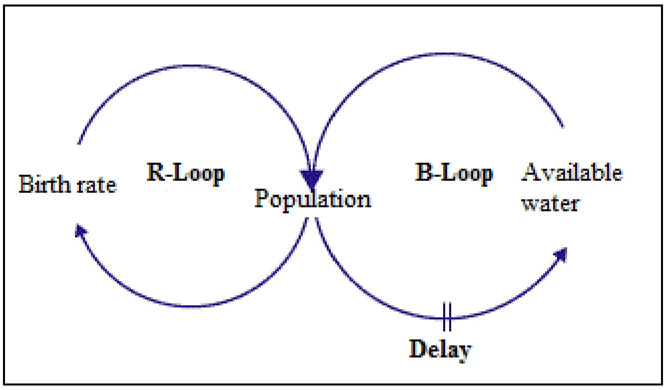

Figure 8. Feedback loops diagram in the story “The Water Hole”

The contents of the child interview were prepared in both Turkish and German, and the consistency of language was checked by experts in translation and interpretation in two languages. The back translation was also undertaken by Turkish-German native speakers in order to ensure that they were identical in content. The necessary revisions were applied to the content in all these processes; then, the interview protocols and the final version of the stories were obtained. Before the children were interviewed, a parent permission form offered detailed information about the study was sent to families through the school management. The children whose permission forms were completed in a positive way by their families were invited to the interview. The children were informed that a story would be read to them and some questions related to the story would be asked. After receiving the verbal consent of the child, the investigator and the child entered the empty interview room. The interviews took 10 to 15 minutes. All the child interviews were begun on the third day of the researchers’ presence in the school after a rapport was built between researchers and participants. All the interviews were audio-recorded for later transcription. The investigator of the study took notes during and after observations.

In order to measure children’s systems thinking skills, the investigator of this research created the Systems Thinking Developmental Rubric for K-Level (see Appendix B) by focusing on eight aspects of systems thinking that are most relevant to the early childhood period. Those aspects presented below can be considered as the building blocks of the systems thinking for young children:

1. Dynamic thinking
2. One-way causality
3. Feedback thinking
4. Big picture thinking

5. Understanding the system mechanisms
6. Problem solving
7. Hidden dimension
8. Time dimension-future prediction

The early version of the rubric was constructed by using the following sources: Ben-Zvi-Assaraf & Orion (2010b); Bell, Grotzer, Donis & Shaw (2000); Ecosystems Rubric of Causal Patterns in Science Project (n.d.); Grotzer & Basca (2003); Sweeney & Sterman, (2007); Perkins & Grotzer (2005); Vineland K-12, (n.d.); Waters Foundation Rubric (n.d.). Then it was submitted to a panel review and pilot application as it was done with other instruments. The content of the rubric was reviewed and renewed at the end of the data collection phase of the research through the initial analysis of the 52 interview transcripts. This time, this version of the rubric was submitted to panel of six educators, experts and researchers who were early childhood educators, academicians and experts in the field of systems thinking and education for sustainability. Accordingly, final version of the instrument was prepared and utilized in data analysis procedure. In each aspect of the rubric, firstly the main assessment aim was defined; secondly, the levels in the aspects were described and thirdly, some examples from the child interviews were presented. Children's total scores should range from 0 to 24.

3.3.1.2 Sustainability and Systems Thinking Indicators Checklist

To comparatively, objectively and holistically reveal the educational contexts of the cases, items in the observation protocols and adult interview protocols were transformed into a checklist. Some of the items in this document were taken from the document "Developing Quality at ESD Schools; Quality Areas, Principles & Criteria" prepared under the scope of the Transfer-21 Programme (Transfer 21 Programme, 2007) and suitable for use as a framework for both internal and external evaluation of schools was adapted to this research. This document defined nine quality areas for ESD schools by combining different elements from *Schulische Indikatoren für Nachhaltigkeits Audit* (SINA Sustainability Audit) (Bormann, Heger, Manthey, Schmalz & Wurthmann, 2004), which in turn was developed on the basis of a range of quality concepts, both from outside the education sector such as the European Foundation for Quality Management (EFQM), the International Standards Organization (ISO) and as well as the quality criteria for the ESD Schools in the SEED Programme (Breiting, Mayer & Mogensen, 2005). Some of the other items were retrieved from the work produced by Hohmann, Weikart and Epstein (2008) on the topic of active learning practices for preschool and child care programs. One item in the checklist was based on the Marion Blank's Levels of Questioning Model as appeared in Massey’s study (2007) on teacher-child conversation in preschool classroom. Other items were created by the investigator of this research.

This checklist document defined six quality areas by combining different evidences collected through different data collection instruments. Some items were integrated into the adult interview questions. Some of the items were also integrated into the observation forms. Other items required a holistic assessment of the collected data to understand whether each case met the selected criteria. The checklist items, instruments and items from those instruments that were utilized while collecting the data were combined in the Instrument-Based Sustainability and Systems Thinking Indicators Checklist (Appendix C). In total, 57 items categorized under the following six quality areas:

1. Preschool climate (6 items): The preschool’s internal dynamics and the level of communication with the outside world is given.
2. Physical space (7 items): Children’s access levels to indoor and outdoor environment of the preschool as well as the educational materials are described. Demonstration of the systems in the physical environment and children’s engagement with systems are explained.
3. Approach to learning and experiences (6 items): The nature of the learning experiences in the case is described by focusing on how learning experiences were connected among each other. Details of the documentation strategies are explained.
4. Thinking and acting routines (12 items): Social and intellectual freedom opportunities provided to children and details on teacher-child conversations are elaborated.
5. Focus on sustainability (9 items): Detailed description of the educational context based on different sustainability-related criteria are provided in order to provide clear understanding of the sustainability compatibility of the case.
6. Systems thinking aspects (17 items): Learning experiences that can be related to the Systems Thinking Developmental Rubric for K-Level and other contextual aspects of systems thinking are described.

As explained above, all the items collected through different instruments were transformed into to a checklist (Appendix D). To what extend the indicator was fulfilled was marked on the checklist under three categories:

1. Not fulfilled
2. Partially fulfilled
3. Fully fulfilled

The checklists were completed individually for each case. In this process, the method is constituted by the investigator and her partners by completing checklists after considering the evidence collected by different data collection tools and then the lists were subjected to comparison. From the comparison, the items that were dealt with in a different way were discussed, and agreement was reached in consequence of the arguments put forward. This process was finalized by completing the final checklist for each case. When this process was finalized, narratives of the case descriptions were created. In the next section, the instruments that were combined into the Sustainability and Systems Thinking Indicators Checklist will be presented.

Through the teacher and the administrator interview protocols, the investigator mainly aimed to collect data concerning the details of the educational context. Some of the questions in the teacher and administrator interview protocols were intentionally designed to be identical because “the qualitative case researcher tries to preserve the multiple realities, the different and even contradictory views of what is happening” (Stake, 1995, p. 12). This was undertaken in order to obtain a sense of variability among the adults employed in the preschool as well as adding complexity and richness to the contextual description.

3.3.1.3 Teacher Interview Protocol

The teacher interview protocol fundamentally consisted of four sections (Appendix E):

-Getting to Know the Context: In this part of the interview, the participants were posed open-ended questions to uncover the details of their educational context including the issues on participation, conflict resolution and decision-making mechanisms, communication among the teaching staff, and documentation.

-Focus on Sustainability: Open-ended questions about diversity and sustainability were posed to the participants in the second section of the interview.

-Pre- and In-Service Teacher Training: In the third part of the interview, the participants were asked open ended questions to clarify the content of training they had received during pre- and in-service training periods. In addition, the participants were asked close-ended questions concerning whether they were familiar with the concepts of sustainability, education for sustainability and systems thinking during their pre- and in-service training periods.

-Getting Know the Teacher: In the last part of the interview, some demographic questions were posed to the participants.

After receiving consent approval of teachers who signed the informed consent form, above-mentioned questions were posed to teachers assigned to the chosen cases, individually and in an environment free from other people. The interview lasted for about 20 minutes. The teacher interviews were performed on the 4th and 5th days of the observation period. It was expected that the transition to the interview after comprehensive information has been acquired through observations would improve the process of making further sense of the observations. All the interviews were audio-recorded for later transcription. The investigator of the study took notes during and after observations.

3.3.1.4 Preschool Administrator Protocol

25-minute interviews were performed with the administrators of the preschools that were collaborating with the research study. The interviews were performed in a quiet environment free from other people. In these interviews, in addition to the questions posed to the teachers, the administrators were asked to respond to open-ended questions concerning the financial resources of the school, socio-economic features of the families, the level of the collaboration of the school with other institutions, purchasing criteria, waste management criteria, and vocational development. The preschool administrator interview protocol fundamentally consisted of four sections (Appendix F):

-Getting to Know the Context: In this part of the interview, the participants were posed open-ended questions to uncover the details of their educational context including the issues on participation, conflict resolution and decision-making mechanisms, communication among the teaching staff, cooperation with outside world, financial resources of the preschool, and socio-demographic characteristics of the parents.

-Focus on Sustainability: Open-ended questions about diversity and sustainability were posed to the participants in the second section of the interview. Additionally, some questions regarding the purchase of goods and materials as well as waste management were asked.

-Pre- and In-Service Teacher Training: In the third part of the interview, the participants were asked open ended questions to clarify the content of training they had received during pre- and in-service training periods. In addition, the participants were asked close-ended questions concerning whether they were familiar with the concepts of sustainability, education for sustainability and systems thinking during their pre- and in-service training periods.

-Getting Know the Preschool Administrator: In the last part of the interview, some demographic questions were posed to the participants.

The preschool administrator interviews were performed on the 4th and 5th days of the observation period. All the interviews were audio-recorded for later transcription. The investigator of the study took notes during and after observations.

The following table (Table 8) presents some sample questions posed to the child and adult participants in the context of the above-mentioned interviews.

Table 8. Sample questions received from the interview protocols

Sample questions received from the Child Interview Protocol	-What was this story about? -Why do you think animals did … (drink, go away etc.)? -Why has the water decreased? -What happened when there was no water anymore? Why? What would this story be like when people were included in the story? -How would you solve this problem if you were one of the animals in the story? -Could you give the book a title?
Sample questions received from the Teacher Interview Protocol	-Could you explain the pedagogical concept of this preschool? -To what extent are administrators, teachers and parents actively involved in decision-making processes? -As the teacher of this learning group, which skills of your students you try to develop most? -How do you document children's learning and development experiences? -What comes to your mind when I say diversity? -Do you somehow focus on diversity issues in this learning environment? If yes, how? -
Sample questions received from the Preschool Administrator Interview Protocol	-Do you work collaboratively with individuals, organizations and authorities outside the school in order to open up external spaces for experience and learning? -What are the financial resources of the school? -Could you explain main socio-demographic characteristics of parents of the learning group that is part of the thesis study? -Are there any criteria regarding the purchase of goods and materials for school use? (Educational materials, food, cleaning materials, stationary, etc.) -What is being done in this preschool to develop teachers' personal and professional competencies?

3.3.1.5 Participant Observations and Observation Protocols

LeCompte and Schensul (1999) defined participant observation as "a process of learning through exposure to, or involvement in the day-to-day or routine activities of participants in the research setting" (p. 91). In this study, observations were conducted in order to create a "relatively incontestable description" (Stake, 1995, p. 62) of the work of the learning groups. They also provided an opportunity to gather information to develop "vicarious experiences for the reader" (Stake, 1995, p. 63). These multiple sources of data add to the richness of the description of the context of the learning groups as well as offering a means of triangulating the data gathered in the interviews. Hays (2004) pointed out that observation was a significant aspect of case study research, especially in school environments in which interaction could not be otherwise comprehended in a sensible manner.

The teachers were informed about the general purpose of the study rather than the specific aims because such knowledge might have affected their planning and changed their normal behavior (Placek, 1984). They were told that the investigator was interested in observing, understanding and describing the day-to-day life of the preschool group and that the specific focus of the study would be disclosed later. The main source of data in naturalistic inquiry is participant observation and the accompanying field notes (Lincoln & Guba, 1985). Denzin (1970) defined participant observation as "a field strategy that simultaneously combines document analysis, interviewing, direct participation and observation, and introspection" (p. 186). In other words, participant observation involves combining a number of methods to obtain the maximum amount of information. The involvement of the investigator/observer in participant observation research can range on a continuum from a total spectator to a full participant in all activities. The role chosen for this study was that of a limited interaction (Schatzman & Strauss, 1973). In taking this role, the investigator tried to disrupt the normal duties and interactions of the preschool group as little as possible but still had the freedom to interact with the participants as well as to ask for clarification and meaning of the observed activities.

Observations were allocated for a total of 20 hours for each case over a period of 5 days to establish prolonged engagement as suggested by Lincoln and Guba (1985). Since the preschool teachers stated that they implemented supervised activities more intensively in morning hours, it was decided that the observations were to be performed in the morning. Observations were carried out in intervals defined as the observation periods in places where the preschool groups were located such as classroom, dining room, playground, preschool garden, and field trip location.

In an attempt to reach systematic and objective conclusions in the study, the observations sought to be undertaken within clear criteria towards systems thinking and ESD. The investigator of this study conceptualized, planned and administered two structured observation protocols (learning experiences and learning environment) aiming to produce a comprehensive understanding regarding the characteristics of the educational contexts from the same structural perspective to allow the investigator to undertake a cross-case analysis.

These sources of data aim to describe the educational contexts and conceptualize the extent to which the learning experiences and learning environments involve the elements of systems thinking and the ESD approach.

3.3.1.5.1 Learning Experiences Observation Protocol

This instrument (provided in Appendix G) was used to observe learning experiences designed by teachers to facilitate the achievement of specific learning outcomes by the children. The form consisted of three parts:

(1) General Characteristics of the Learning Experiences: Number of children and adults present in the case, characteristics of the adults and daily flow of the case is described.
(2) Quality Indicators: This part of the form covers the interaction between teachers and students during the observation time. To what extent the indicators were fulfilled is marked and description regarding those indicators are provided. The intention of this section is to demonstrate the characteristics of the adult-child interaction as well as the extent of the coverage of systems thinking and sustainability.
(3) Other Characteristics of the Learning Environment: Documentation techniques utilized in the case are described and space for the description regarding the special aspects of the learning experiences are provided.

The investigator and her partners[7] took field notes from the moment they began the observation by taking into account the items on the observation form. All the observations were examined at the end of each observation day, and after discussion and attaining mutual agreement, one Learning Experiences Observation Form were completed to depict the learning experiences of that day. After all the observation processes for one case were undertaken, the completed forms were reexamined and one final form for each case was completed to be used in the data analysis.

3.3.1.5.2 Learning Environment Observation Protocol

This instrument (presented in Appendix H) was constructed to achieve three main purposes. The first objective was to depict the learning environment of the chosen learning group; the second was to determine the extent to which the learning environment in which

[7] Detailed information about the researchers are provided in section 3.3.3.

children spent time had the potential to enhance their systems thinking skills, and the third was to collect evidence related to the Sustainability and Systems Thinking Indicators Checklist connected to the physical environment of the learning groups. The form consisted of three parts:

(1) General Characteristics of the Learning Environment: Size and general characteristics of the indoor and outdoor environment of the preschool are described.
(2) Quality Indicators: To what extent the indicators were fulfilled is marked and description regarding those indicators are provided.
(3) Other Characteristics of the Learning Environment: Topics of the wall displays, materials and books present in the learning environment, maps of the indoor and outdoor environments are presented[8]. In addition, the list of books available to the children and teachers in the visited cases was acquired to reveal the status of reading material quantitatively in learning environments and detect the presence of reading materials that may be linked with ESD and systems thinking skills.

The investigator and her partners fill in the Learning Environment Observation Protocol individually. All the observation forms were examined at the end of the first observation day, and after discussion and attaining mutual agreement, one Learning Environment Observation Form for each case was completed to depict the learning environment of the case. If needed some additions made to the form throughout the observation period by mutual agreement of the observers.

3.3.1.6 Field Notes

In addition to the instruments described above, detailed field notes of all the observed activities and conversations were taken to be examined at the end of each day. While collecting data, the investigator also posed additional questions as the research progressed due to the emergent nature of qualitative inquiry. In order to elaborate a more contextual understanding of each case, new questions were directed to clarify the observational/document data and elicit information that was not obtained during the observations. This acquired information was added to the field notes. Since the process of detailed description continued for five days, the investigator was particularly able to watch

[8] Spaces were provided for observers to draw a sketch of the indoor and outdoor learning environments.

for any repeating patterns and themes, which could be further probed by redirecting the observations or through informal questions.

3.3.1.7 Additional Documents

In order to increase the confidence in the interpretation and support the depth of the study, other sources of data such as the website of the preschool and the teacher's lesson plans were examined to support the quality indicators occurred in the Sustainability and Systems Thinking Indicators Checklist. The investigator examined the written documents to gain a deeper understanding regarding the learning contexts (Bodgan & Biklen, 2006). Those documents were exposed to content analysis to depict the pedagogical concept of the preschool in detail to the readers of the study. In addition, documents were collected to corroborate the observations and interviews to generate further trustworthiness among data (Glesne & Peshkin 1992).

3.3.2 Panel Review and the Pilot Application

All the instruments were submitted to a panel of eight educators, experts and researchers who were early childhood educators, academicians and experts in the field of systems thinking and education for sustainability. Seven experts gave the researcher their comments. The researcher reviewed the comments and revised the instruments and the story content accordingly to produce the final versions of the instruments to be pilot tested.

The inclusion of a pilot study can ensure triangulation and increase validity (Stake, 2006). Therefore, a pilot study of the interviews and the survey was conducted with two Turkish and two German preschool children as well as two Turkish and two German preschool teachers. These preschool teachers were also presented with the questions that were to be directed to the preschool administrators. The teachers submitted their comments to the researcher which helped her refine the questions. The feedback obtained from the child and adult participants in the pilot study was used to tailor the interview approach used for this study and increase the alignment of the data collection (Creswell, 2007). The results of the initial pilot study interviews revealed that interview questions required more time to respond to than had previously been planned and this had a negative effect particularly on the children who had limited attention spans. The child interview was revised to be conducted in sessions of 10-15 minutes. Some questions were removed from the interview, others were relocated, and a few new ones were added. Before entering the field, the researcher pilot-tested the latest version of the child interview with four preschoolers (two

Turkish and two German children) and the final versions of the interview protocol and story book were achieved. Since it was concluded that the adult interviews took too long in the pilot testing, some questions were distributed between the teacher and preschool administrator interview protocols, and document analysis was used to collect data on certain points.

3.3.3 Information about the Researchers

Creswell (1998) defined the role of the researcher in qualitative research as: "The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting" (p. 15). According to Merriam (1988), Yin (1994), Patton (1990), and Hatch (2002) in qualitative research, researcher should be perceived as one of the data collection instruments. The following section gives information regarding the researchers active during data collection, data analysis and audit trail phases.

3.3.3.1 Data Collection Phase

The investigator of this research is a PhD candidate in the field of Early Childhood Education (ECE) and a Turkish citizen. Her expertise is in education for sustainability. She has advanced proficiency in English and intermediate proficiency in German. She has previously held positions such as Senior Trainer, and Project Coordinator at different educational projects supported by international and national funding programs. During these assignments, the researcher gained extensive experience in educational materials/lesson planning/curriculum development for trainers, teachers and children. The Green Railway Wagon, one component of the Green Pack Project in which she worked as Project Manager was awarded "Good Practice in Education for Sustainable Development in the UNECE Region" by UNESCO. The researcher conducts research in transformative learning focusing on education for sustainability to add value to the current literature. She executed the data collection and data analysis procedures in the current study.

The researcher worked with a Turkish and German partner during the data collection process of the research. Three training sessions were conducted with both partners before going into the field and each session took around three hours to complete. In these sessions, aim of the research, participants, data collection instruments were presented. Reading assignments were given in order to improve the performance of the partners. This learning process continued during the field work when examining the case study sites and observing events and interactions.

While collecting data from the Turkish cases, all observations were carried out together with the Turkish research partner with mutual discussions being conducted during the completion of the observation forms and the checklists and the observational study was terminated when consensus was reached. This partner can also be described as a Turkish reliability observer who holds a bachelor's degree in Psychological Counseling and Guidance and is a nature lover familiar with sustainability issues. The same process carried out in Turkey was also undertaken with a native German speaker who lives in Germany. All observations were performed with this reliability observer who is also a preschool teacher, and the completion of the observation forms as well as the checklists were discussed and agreed. In addition, detailed information on preschool education systems and applications in Germany was obtained from this partner throughout the process. The German research partner also interviewed the child and adult participants. Prior to the interview, training sessions were conducted with the partner. After these training sessions, a trial interview was made with two children in the German context. The researcher provided feedback to the partner during these trial interviews and the process was refined. The researcher was present in the room during the interviews and was included in the interview process when necessary.

3.3.3.2 Data Analysis Phase

The observation forms and Sustainability and Systems Thinking Indicators Checklist were completed with the collaborating researchers while doing field observations as described above. The investigator of the research carried out the analysis process by reviewing these completed forms. The interview analysis process was performed with the collaboration of two additional researchers. The first researcher has a PhD degree in the field of education, and specializes in systems thinking and ESD. The second researcher is a PhD candidate in the field of ECE and specializes in early childhood education and ESD.

3.3.3.3 Audit Trail Phase

In this study, an audit trail was used to establish the rigor of a study by providing a group of academicians with the details of data analysis and some of the decisions that led to the findings. Since the research is a dissertation study, all the research processes and stages were carried out and completed under the supervision of the thesis advisor, co-advisor, and mentor. Furthermore, the progress achieved in the research was presented periodically to the Thesis Inspection Committee and the researcher received comments and suggestions concerning the study. The main advisor to the research is a Turkish citizen. She is an associate professor of ECE at Middle East Technical University, Ankara, Turkey. Her research interests include science education in the early years, environmental education, ESD and assessment in ECE. The co-advisor for the current research is a Turkish citizen who is a professor in ESD at Middle East Technical University. Her research interests are focused on the theory and applications of Environmental Education, ESD and Climate Change Education for Sustainability. The academician who was the mentor for the study is a German citizen and a professor of ESD at the Leuphana University of Lüneburg in Germany. His passion is focused on research and teaching for sustainability with an emphasis on competence development, innovative learning settings, and curriculum change.

As suggested by Lincoln and Guba (1985), raw data, data reduction and analysis products, data reconstruction and synthesis products, process notes, materials relation to intentions and dispositions, and instrument development information were submitted to the auditors during the audit trail process in order to assess whether the dependability and credibility issues had been appropriately managed within the study.

3.3.4 Limitations During Data Collection

Although the aim was to keep the socio-economic levels of children as similar as possible when carrying out the sampling, this was not perfectly realized. The evident difference in the income inequality and the differences in social and educational policies between the two countries are the reasons behind this limitation. Inequality in income distribution in Turkey is higher than in Germany. In addition, the family profile in preschool institutions in Turkey displays a more homogeneous structure in that white-collar families generally prefer certain types of preschools while the children of blue-collar families attend different types of preschools. Conversely, in Germany, the family profiles of the children attending the same preschool exhibit great variations.

Germany has a more egalitarian structure in income distribution than Turkey[9] in terms of the instrument known as the Gini coefficient and used as a measure of inequality. This is one of the factors that also homogenize the social socio-economic level distribution. ECE in Berlin is subsidized by the state and education is free of charge and families generally send their children to the institutions that are closest to their residence or workplace. The socio-economic profiles of families display a particularly diverse picture, especially in centralized neighborhoods. The child of an artisan who works in a small shop and a child of a highly trained white-collar family residing in the same neighborhood benefit from the same preschool education and care services. Thus, the socio-economic levels of the families of children who attend the same preschool have a heterogeneous structure as the family's financial status is not the criterion for the child to be accepted by the preschool. In Turkey, well-educated families, more likely to be members of the middle and upper socioeconomic segment of society, often send their children to private preschools. While children who attend state preschools are more likely to be from lower and middle socioeconomic families. Due to this structural difference between the two countries, it has not been possible to balance and clearly distinguish the educational level of the parents of the children participating in the study.

Another limitation arises when data being gathered in the study is related to age groups in ECE in two countries. In Turkey, according to the Ministry of National Education regulation, children can start primary education at the age of 5. All boys and girls at the age of 5.5 should start primary education. However, children can delay the start primary education until the age of 6 upon the request of their parents and with the approval of a medical practitioner. In Germany, the situation varies from state to state. In the state of Berlin, children must be at least 71 months old at the date they start school. The difference in educational policies in terms of the age of starting school in the two countries directly affected the age group distribution of the children participating in the study. The children participants attending the Turkish preschools were aged between 4 and 5 years; however, the German child participants were between 5 and 6 years old.

---

[9] The inequality measurement is obtained using the index provided by Gini coefficient. The Gini coefficient is a number between 0 and 1, where 0 corresponds to perfect equality (where everyone has the same income) and 1 corresponds to perfect inequality (where one person has all the income—and everyone else has zero income) (OECD, 2017). Turkey's Gini coefficient corresponds to 0.393 and Germany's Gini coefficient is equal to 0.292 according to the 2014 survey retrieved from https://data.oecd.org/inequality/income-inequality.htm

Since the attention spans of the child participants in the study are limited due to their developmental level, it was necessary for the interview to be kept short. Though asking more questions in the child interviews regarding the first research question would help to obtain more diverse and qualified data, some questions were not been posed to the children due to this attention span limitation.

As explained in the introduction to this study, despite being considered as important, the integration of systems thinking into education can still be described as limited (Jacobson & Wilensky, 2006; Plate, 2010). The investigator of this study faced many limitations during both the data collection and analysis phases of the study due to the absence of studies that focus on the initial systems thinking skills of young children.

3.3.5 Ethical Considerations and Entering the Case Sites

This research study was given ethical approval by the Ethics Committee of the Middle East Technical University. There were a number of key ethical considerations to be taken into account when conducting the research. These included maintaining the confidentiality of the identity of the children, teachers and preschool administrators, accurately representing the experiences and perspectives of the research participants, and empowering the participants so that they trusted and felt comfortable with the research process. Following Creswell's (1998) model for gaining consent approval, the adult participants were given an informed consent form to sign (can be found in Appendix I). The components of this approval included: (a) voluntariness of participation, (b) the participants' right to withdraw from the study at any time, (c) an explanation of the purpose of the study and the data collection procedures to be used, (d) an assurance of confidentiality statement, and (e) a signature and date giving permission to participate in the study. The children whose permission forms were completed in a positive way by their parents (Parent Permision Form is provided in Appendix J) were invited to the interview. The child interviews began after receiving verbal consent from each child. Then, the investigator continued the process by selecting key informants and familiarizing herself with the setting as well as the culture in the setting (Bernard, 1994).

3.4 Data Analysis

According to Bogdan and Biklen (2006), data analysis is a systematic process of sifting and arranging all the information obtained from different forms of resources collected to increase the understanding of the data to enable the investigator to present the findings.

Yin (2003) argued that data analysis consisted of “examining, categorizing, tabulating, testing, or otherwise recombining both quantitative and qualitative evidence to address the initial propositions of a study” (p.109). In general, “data analysis means a search for patterns in data” (Neuman, 1997, p. 426). As Neuman (1997) stated that as soon as a pattern was detected, the researcher ascribed the pattern from the point of a social theory or the scene where it appeared, and the qualitative researcher moved from the definition of a historical deed or social surroundings to a broader reading of its meaning. Principally, “the ultimate goal of the case study is to uncover patterns, determine meanings, construct conclusions and build theory” (Patton & Appelbaum, 2003, p. 67). Yin (2003) defined the following three general analytic strategies for analyzing case study evidence: relying on the theoretical propositions that lead to the study, thinking about rival explanations, and developing a case description.

In this study, data analysis started with a preliminary exploratory analysis (Creswell, 2005) with all the evidence gathered throughout the process. After the transcription of the audio-recorded interviews, the investigator assembled the raw data, including available documents such as the checklist, observation protocols, and field notes. After gaining familiarity with the documents and searching for general ideas, coding was carried out focusing on both descriptive and thematic data (Creswell, 1995). “For more important episodes or passages of text, we must take more time, looking at them over again and again, reflecting, triangulating, being skeptical about first impressions and simple meanings” (Stake, 1995, p. 78). Next, the investigator decided to separate the data analysis work into three different paths compatible with the three research questions posed in the study. The findings were compared across cases to determine similarities and differences.

3.4.1.1 Conceptualization of the Young Children’s Systems Thinking Skills

According to the first research question, the characteristics of the systems thinking skills of preschool children need to be explored. To accomplish this aim, “The Water Hole” written and illustrated by Graeme Base was read to the child participant and questions were posed to the child during and after the reading. The data obtained from this process, labeled the child interview, was analyzed using the grounded theory approach because it was believed that a theory could appear through a qualitative data analysis (Strauss & Corbin, 2008). The data was consequently broken down into steerable units and the coding was completed as intrinsic parts of the analysis (Miles & Huberman, 1994). As advocated by Miles and

Huberman (1994) data reduction is carried out on a variety of different sources of data used by the investigator including the selection, simplification, abstraction and transformation of the raw data.

The investigator used the constant comparative method to improve the data by coding and analyzing simultaneously (Taylor & Bogdan, 1998). The constant comparative method is a process which unites systematic data collection, coding, and analysis with theoretical sampling to develop a theory which is unified, close to the data, and conveyed in a shape which is sufficiently lucid for further testing (Conrad, Neumann, Haworth, & Scott, 1993). This methodology merges these four phases: “(1) comparing incidents applicable to each category, (2) integrating categories and their properties, (3) delimiting the theory, and (4) writing the theory” (Glaser & Strauss, 1967, p. 105). Throughout the four stages of the constant comparative method, the researcher continually sorts through the data collection, analyzes and codes the information, and reinforces the theory generation through the process of theoretical sampling. Employing this method is useful because the research starts with raw data and it is considered that a substantive theory will appear via continuous comparisons (Glaser & Strauss, 1967).

The coding of the data analysis was achieved through three analysis levels: (a) open coding, (b) axial coding, and (c) selective coding in order to interpret a full apprehension of the information derived during data collection process (Strauss & Corbin, 2008). The researcher continually equated the data and posed questions about what is and is not comprehended throughout the first stage of the coding process. The researcher linked data together in novel ways throughout the axial coding procedure in order to make connections between categories possible. Through posing constant questions, not only inductive but also deductive thinking processes of incorporating subcategories into categories were employed. In the last phase of coding, selective coding was undertaken by distinguishing and choosing the core categories placed as levels in each aspect of the systems thinking. The researcher systematically checked the other categories as well as validating alikeness and relationships among all the levels. Responses of the children were coded and assigned to one of four levels in each aspect on a scale ranging from Level 1 şto Level 4 due to two main reasons: (1) the former studies in the field produced developmental rubrics with four levels, and (2) experience in many studies demonstrated that making distinctions among four or fewer criteria provided better results (Griffin & Robertson, 2014). At the end of the process, a total score for each child was assigned. The researcher coded entire set of data, refined the tool throughout the process and shared it with the panel reviewers for further comments and revisions. When the final version of the instrument was constructed the first and the second reliability coders coded twenty-five percent of the data to check for inter-rater reliability. The scorers made 104 decisions of which they agreed to 95 of them--91% (first reliability coder) and 93 of them--89% (second reliability coder) of the decisions made. Discrepancies were discussed and resolved until there was 100% agreement.

3.4.1.2 Interaction Patterns between Systems Thinking and Educational Contexts

For the second research question, the aim was to reveal how the children's systems thinking skills are affected by the educational context in which they were located. To respond to this question, the data obtained from different data collection instruments used in the research were taken into account. After the documents became familiar and were examined for common views, an analysis was performed for both descriptive and thematic data (Creswell, 1995). In order to constitute themes for cases one by one, descriptive codes were designed from the holistic analysis of the data. The context of each case study covered the examination of all the data. The consequences obtained from the data sources were compared to reinforce validity and employ a time-series individual-level logic model as suggested by Yin (2003) for individual case studies: "For the text's significant chapters or passages, we must take more time, check out them over and over, displaying, triangulating, being suspicious about first feelings and simple meanings" (Stake, 1995, p. 78). This holistic analysis was carried out by using the themes that were established from the responses to the second research question. In this process, the first focus was on the Learning Environment Observation Protocol to physically analyze the learning environment. The aim was to make both the description of the learning environment and the relationship with STS and ESD in terms of the items identified in this form. Secondly, the purpose was to clarify the nature of the learning experiences as well as the interaction between the teachers and children through the Learning Experiences Observation Protocol. In addition, this form was employed to determine whether learning experiences constructed by teachers included elements to enhance the children's systems thinking skills. Thirdly, transcripts of the teacher and preschool administrator interviews, the field notes and additional documents were analyzed to contribute to the description of the educational context. Finally, all the cases were subjected to an evaluation according to the Sustainability and Systems Thinking Indicators Checklist from a holistic point of view in the evanescent light obtained from different instruments. By using the same criteria in this assessments, it was revealed that educational contexts had either dominantly alternative or mainstream pedagogical features.

3.4.1.3 Interaction Patterns between Systems Thinking and Educational Contexts Across Cases

Within the scope of the last research question, the target was to make comparisons between cases and a cross-case analysis was conducted for this purpose. As Stake (2006) suggested, a multiple data analysis orientation can be included in cross-case study analysis. In the current research, three data analysis orientations which were not independent but different were employed. The first orientation was the contextual affirmations that arose from the individual case studies. The second orientation was directed by the case studies through directly evaluating findings related to the research questions led by the variables of interest. Thirdly, important concepts which emerged but failed to fit common themes were also remarked upon and analyzed as a part of this study (Patton, 2002; Stake, 2006). All three orientations were processed as influences for comprehending and amalgamating the cross-case assessment and debate to reinforce and strengthen the understanding of the research topic. At the end of this process, potential key variables related to the systems thinking skills of children and contextual factors that may have an effect on those skills emerged to be discussed in detail.

3.5 Establishing Trustworthiness

Trustworthiness in qualitative research is a means of ensuring that findings are worthy of the attention of those who will make use of them. It relies on the skill and integrity of researchers who conduct it. Lincoln and Guba (1985) suggest four characteristics of trustworthy or reliable qualitative research: credibility, dependability, transferability, and conformability. The techniques used in this research to establish trustworthiness are presented in the following section and a summary of those techniques is displayed in Table 9.

This case study sought credibility through prolonged fieldwork in each of the five sites and use of a source (child, teacher, preschool administrator) as well as a method (observation, interview, document analysis) triangulation. Credibility is also influenced by the researcher's credentials, which have been noted earlier in this chapter. Frequent debriefing sessions between the investigator and her research advisors were held to establish credibility by probing the investigator's biases, and exploring the meanings and the interpretations.

Table 9. Summary of techniques for establishing trustworthiness

Criterion Area	Technique
Credibility	(1) activities in the field that increase the probability of high credibility (a) prolonged engagement (b) triangulation (sources, methods and investigators) (2) peer debriefing (3) member checks (in process and terminal)
Transferability	(4) thick description
Dependability	(5a) the dependability audit, including the audit trail
Confirmability	(5b) the confirmability audit, including the audit trail
All of the above	(6) the reflexive journal

Source: Adapted from Lincoln and Guba (1985)

In addition, these sessions provided the opportunity to develop the next steps in the emerging methodological design. Finally, these sessions provided the investigator with the opportunity to clear her mind of emotions and feelings that may be clouding good judgment or preventing the emergence of the logical next steps. Member checking was also undertaken to establish the credibility of the research by presenting the interpretations and conclusions in an informal way to the adult participants of the visited cases both during the visit to the cases and at the end of the data analysis procedure.

In order to address the dependability issue, the processes within the study should be reported in detail, thereby enabling a future researcher to repeat the work but not necessarily to gain the same results (Lincoln & Guba, 1985). For readers of this research report to develop a thorough understanding of the methods and effectiveness, this research text includes sections devoted to (Shenton, 2004, p.71-72):

a) research design and its implementation (describing what was planned and executed on a strategic level)

b) operational detail of data gathering (addressing the minutiae of what was carried out in the field)

c) reflective appraisal of the project (evaluating the effectiveness of the process of inquiry undertaken)

To increase dependability, the investigator used peer examination both within and across sites. Furthermore, an audit trail of raw data, coded data and case reports was established as it has been suggested that the dependability of the data is assessed through the use of an audit trail to ensure accurate data collection (Guba, 1981; Koch, 1994).

Though the study does not seek generalizability, it points towards transferability through purposeful sampling and utilizing a dense description within case reports. This permits readers to move from the facts to the perspectives of the teachers, children, and administrators who took part in the study and presented their voices, feelings, actions, and meanings (Denzin, 1989). It was argued by Holloway and Wheeler (1997) that the findings obtained from case study research were naturally hard to utilize in a wider population because of the focus on an individual case in a specific setting. Meyer et al. (2000) also acknowledged with this predication and found that single case study formations did not represent a population itself. Corcoran, Walker and Wals (2004) considered that case study research was introspective and took place in just a single setting. They suggested that if the study aimed to remodel practice in just one particular setting, this introspection could be suitable. Nonetheless, it is acknowledged that they recognize that if the purpose of the case study research is to contribute to a wider evidence base, this has implications for the way the case study is conducted and disseminated. Though it is extensively believed that such conclusions could not be easily applied to a broader research population (Burns & Grove, 1997; Yin 1994), they are largely suited to the generation of theories. Yin (2003) also agreed that it was essential for the case study approach that the methodology was established to broaden and generalize theories and to be utilized by a broader research population (Yin 1994).

Lastly, confirmability in the furtherance of the data and judgments concerning the data were grounded in events rather than the researcher's personal biases and constructions (Lincoln & Guba, 1985). Mitchell (1983) stated that the truth value of the results obtained from a case study was well acquired since the research was conducted in a real-life context, thus intrinsically amplifying the researcher’s credibility. As with the truth value, the triangulation of data, use of observer notes and reflexive journals, the project's audit trail, collaboration of two researchers in each site, and review of documents and findings by the project's research team support the conformability of findings in this research project (Bryar, 2000; Burgess, 1984; Krefting, 1991; Lipson, 1991; Tellis ,1997; Thompson, 2004).

CHAPTER

FINDINGS

In this chapter, the findings obtained within the scope of the research questions will be presented. The general profile of the child and adult participants involved in the study will be introduced to illuminate the findings. Then, in response to the first research question, the nature of the young children's systems thinking skills will be revealed based on Systems Thinking Developmental Rubric for K-Level in order to conceptualize a child's early steps toward systems thinking.

In the second part of this chapter, a description about the contexts of the cases will be presented to answer the second research question of the study. To define these contexts, the data obtained from field notes, supervised activities observation form, learning environment observation form, reflexive journals and adult interviews will be processed through the lens of the Sustainability and Systems Thinking Indicators Checklist.

Finally, in response to the third research question, findings related to the first and second research questions will be synthesized through a cross-case analysis to compare and contrast the given findings to obtain a more holistic understanding related to systems thinking skills of young children in certain educational contexts.

4.1 Profile of the Participants

The profiles of the two types of participants in the research, adults and children, are presented in the next section.

4.1.1.1 Profile of the Child Participants

In the scope of the exploration of the systems thinking skills of young children, 57 child participants were interviewed in total by the investigator and her partners. From this process, the interviews of five children were not included in the study. One was the child of a Syrian refugee family who had recently settled in Germany, and was in the course of adapting to the German context. Two of the interviewed children were considered to have special needs and were excluded from the data analysis. Two of the interviewed children talked very little during the interview, and the investigator decided not to complete the interview in order not to upset the children. The final number of child participants in this study was 52. Information on the general characteristics of children is detailed in Table 10.

Table 10. Profile of all the child participants

	Characteristics	Frequency	Percentage
Gender	Girls	27	51.9%
	Boys	25	48.1%
Age	48-59 months old	17	32.7%
	60-71 months old	27	51.9%
	72+ months old	8	15.4 %
Bilingual	Yes	12	23.1 %
	No	40	76.9%
Education Level of One of the Parents	University degree or above	41	78.8%
	Less than university degree	11	21.2%
Mean ECE Enrolment Age: 28 months old			
Mean Age: 62 months old			

N=52

As displayed in Table 4.1, gender distribution of participants is balanced; 27 female children and 25 male children were interviewed. The age distribution of children is as follows: 17 children between 48-59 months old, 27 children between 60-71 months, and 8 children 72 months and above. Based on this distribution, about half of the participants were around 5 years old. The mean age of all participants was calculated as 62 months. Of the children participants, 23.1% were bilingual. Regarding the educational level distribution of the children's parents, 41 children (78.8%) had at least one parent with a university first degree or above level of education. The mean early childhood education (ECE) enrolment age of this group was 28 months old.

4.1.1.2 Profile of the Adult Participants

Eleven adults participated in the study. The distribution of adult participants is demonstrated in the following table (Table 11).

Table 11. Distribution of adult participants

<table>
<tr><td rowspan="1">Alternative Education Preschool in Turkey (A-TR)
Number of administrator participants: 2
Number of teacher participants: 1</td><td colspan="2">Alternative Education Preschool in Germany (A-GR)
Number of administrator participants: 1
Number of teacher participants: 1</td></tr>
<tr><td rowspan="2">Mainstream Preschool in Turkey (M-TR)
Number of administrator participants: 1
Number of teacher participants: 1</td><td>Mainstream Preschool in Germany- Preschool Group with medium SES parents (M-GR-M)
Number of teacher participants: 1</td><td>Mainstream Preschool in Germany- Preschool Group with low SES parents (M-GR-L)
Number of teacher participants: 2</td></tr>
<tr><td colspan="2">Number of administrator participant from M-GR-L and M-GR-M cases: 1</td></tr>
</table>

General information about adult participants' profiles is provided in Table 12. One of the adult participants was male and the others were female. Most of the adult participants (72.7%) had a vocational school education. The average age of the participants was 47.8 years old. On average, they had 25.2 years of teaching experience and had been working at the current preschool for an average of 10.3 years.

Table 12. Profile of the adult participants

	Characteristic	Frequency	Percentage
Gender	Female	10	90.1%
	Male	1	9.1%
Educational Background	Vocational training	8	72.7%
	University	3	27.3%
Average professional experience (year-based)		25.2 years	
How many years s/he working in a preschool (average)		10.3 years	
Mean age		47.8 years old	

N = 11

4.2 Findings Related to the Systems Thinking of Children

In this part of the study, findings obtained within the framework of the following research question are presented: what are the levels of systems thinking skills of 4- to 6-year-old preschool children in Turkey and Germany?

As reported in the previous chapter of this study, the child participants were interviewed to gain an understanding of how their systems thinking skills through eight different aspects of systems thinking can be conceptualized:

1. Dynamic Thinking
2. One-way Causality
3. Feedback Thinking
4. Big Picture Thinking
5. Understanding System Mechanisms
6. Problem Solving
7. Hidden Dimension
8. Time Dimension-Future Prediction

In this interview, the selected story, the Water Hole, was read individually to each participant. Some questions were posed while reading, and others were directed to individual participants after completion of the story. The data analysis was based on the Systems Thinking Developmental Rubric for K-Level and the findings from the eight aspects are presented below.

4.2.1 Dynamic Thinking

Systems thinkers are able to detect the dynamic components within systems because they have the ability to see patterns of change rather than recognizing only static snapshots (Senge, 1991). The nature of the water throughout the Water Hole story can be classified as one of the most visible dynamic behaviors in the system that arises from the interaction of a system's components over time. In order to reveal opinions of the child participants related to the dynamic nature of water, the question "something has begun to change, can you think about what has changed?" is asked. At this stage, the children were expected to clearly comprehend and describe the regular decrease in the amount of water that occurred during the story, as well as its disappearance, and re-existence.

The water hole in the story has a different feature from the other variables. The water hole exhibits a dynamic behavior over time; its amount varies with inflow and outflow, and it is expected to be differentiated from other variables. As shown in Table 13, one child did not give a relevant response regarding the change in the level in the water hole (Level 1, Score=0). The existence and disappearance of water was recognized by 51 children (Level

2, Score=1). Thirty-nine of the children (75%) were aware of the gradual change regarding the amount of water; in other words, they could differentiate the water hole as a stock variable (Level 3, Score=2). The children who could not define the gradual change on the size of the water had ideas that the water increased and decreased from time to time or its color had changed. The skill of recognizing gradual change is directly related to the ability to observe the behavior of water within a certain time. The relationship between this skill and the time dimension will be explored in more detail in the discussion chapter of the study.

Table 13. Dynamic thinking

Characteristics	Frequency	Percentage
Level 4-Hidden Pattern	4	7.7%
Level 3-Obvious Gradual Change	39	75%
Level 2-Obvious Sudden Change	8	15.4%
Level 1-No Change	1	1.9%

N=52

Only four child participants were able to detect a circular dynamic behavior pattern which requires the application of much longer time-view by involving both obvious and hidden components and processes. Without giving the children any preliminary information, the aim was to reveal the initial abilities of children about the movement of water by asking where the water in the story might have come from, where it might have gone, and who/what needs water. Although the story has clues related to the cyclic movement of water in the story, this phenomenon has not been clearly visualized to the children. Moreover, children needed to master all hidden the components and processes in order to be able to display a holistic view of this natural phenomenon. As the findings of the study revealed and explained later in detail, children's abilities were limited in terms of seeing and processing hidden components and processes within the systems. From this point of view, the responses of the children were focused on the partial components and processes of the water cycle. The most comprehensive answer to the cyclic movement of water came from the participant, Ben Alex, who suggested that the water might have come from underground. He realized at the beginning of the story that the water was decreasing and gave the following as a possible reason:

"Because the sun is drying the water, a little water goes up, into the clouds. Then, it comes down again as rain, comes up from the underground" (Ben Alex, A-GR).

Other examples of cyclic approach evidence are given below:

“... the water comes from the earth and the sky, and it goes underground again ... The water comes from the sky, goes underground and then comes out again ...” (Anselm, A-GR)
“... water comes from the sea; the animals are drinking water... water may be running down because it is going to the sea” (Sura, A-TR)
“...water comes from the ocean ... at the end of story, all the animals swim to the ocean, there is a whale here, and some of these animals were eaten by the whale…” (Lukas, M-GR-M)

In conclusion, a total of four children's interview transcripts contained evidence, though limited, of the circular movement of water. The findings of the study revealed that children's responses were more likely to be evaluated as a back-and-forth movement of water rather than a circular movement. One of the most comprehensive answers related to the behavior of water belonged to Louisa (M-GR-M), who, although talking about multiple components and processes that can be evaluated within the water cycle, could not generally place the behavior of water in a circular pattern:
“... the water comes from the sea ... goes to the stomach of the animals ... other than animals, people, flowers, soil and the sun use water ... the soil needs water to breathe ... the water is completely dry because the sun is coming out ... after the rain has fallen, water will go again, because the sun will dry it...”

4.2.2 One-Way Causality

As explained in the Causal Patterns in Science Project (n.d.), it is the tendency of the human mind to build simple cause and effect relationships to explain what happens in our world. However, the world does not function in that simple way. For instance, when there is an oil leak in one place, this can affect the migratory bird and fish population elsewhere. To become a systems thinker, it is important to build up set of causal patterns that capture greater complexity. Accordingly, in this part of the study, the aim was to detect the children’s more sophisticated one-way causality construction abilities by asking different “why” questions such as: Why do you think animals did…. (drink, go away etc.)? What happened when there was no water anymore? Why? What caused the animals to return to the forest? Each individual interview was analyzed holistically to reach a conclusion related to the linear causality abilities of the young children. The findings of the study shown in Table 14 revealed that all the participant children were able to build up a linear cause-and-effect relationship. Fourteen built a one-way relationship between one cause and one effect (Level 1). Thirty-six child participants went further and described either two-step linear connections that result in direct and indirect effects or multiple one-way simple causality. This means that they were able to detect multiple causes and/or multiple effects; e.g., A and B are causes of C and/or D causes E and F. This level requires abstract thinking because the story openly provides the children with one cause-one effect relationships.

Table 14. One-way causality

Characteristics	Frequency	Percentage
Level 4-Three or More-Step Domino Causality	2	3.8%
Level 3-Two-Step Domino Causality OR Multiple One-Way Simple Causality	36	69.2%
Level 2-One-Way Simple Causality	14	26.9%
Level 1-No Causality	0	0%

N=52

Only 3.8% of the children reached Level 4 through expressing a three- or more-step domino causality as in this example extract:

"If there is no water, we can't wash our hands. Then, there will be bacteria all over our body and we will get sick" (Eda, M-TR).

4.2.3 Feedback Thinking

As Plate (2006) underlined, understanding non-linear causality is at the center of systems thinking. This skill necessitates a modification in the fundamental model of a causal chain in the causal web. In this part of the research, the capacity of the child participants to construct causal relations was further tested to evaluate their ability to detect the behaviors in the system that can feedback to form positive and negative processes (Sweeney & Sterman, 2007). Two types of feedback loops are found in the universe: reinforcing and balancing, also called positive and negative feedback loops. When a change occurs within something, over time this change returns to evoke a further change in that very thing; then, a feedback loop emerges. A positive or reinforcing loop emerges if that further change is in the same direction. A negative or balancing loop, also called a goal-seeking loop, emerges when it is in the opposite direction.

As explained in the website www.thwink.org, population growth is an example of reinforcing loop. The more the population scales up, the more births increase per year. The more that scales up, the more the future population also scales up. The loop continues round and round (reinforcing loop in Figure 9) and grows exponentially till it goes beyond its limits.

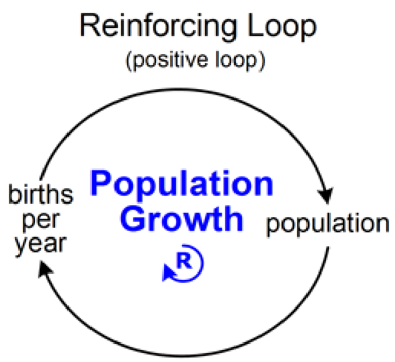

Figure 9. A reinforcing loop (Thwink.org, n.d.)

This behavior leads the population to approach step by step the carrying capacity of the system because the system can only assist a limited number of people. The population will be prone to exceed the carrying capacity, and there will be a sudden collapse (balancing loop in Figure 10) because of the long delays in the recognition of environmental degradation in practice.

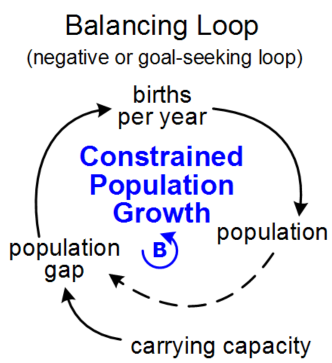

Figure 10. A balancing loop (Thwink.org, n.d.)

Recognizing feedback loops starts with the description of the interdependent relationship between two components. As Senge (2001) pointed out, we live in webs of interdependence, and in the Water Hole story, the most obvious interdependence is the relationship between the water and animals. When the water runs out, the animals in the story leave. When water appeared again, the animals return. As demonstrated in Table 15, most of the children (46 participants) were able to close the loop between two components in the system by recognizing the simple interdependence between the animals and the water. This interdependency is the most obvious relationship in the above surface level.

Table 15. Feedback thinking

Characteristics	Frequency	Percentage
Level 4-Multiple closed loops	2	3.8%
Level 3-Behaviour of closed loop over time	27	51.9%
Level 2-Closed loop	17	32.7%
Level 1-Open loop	6	11.5%

N=52

Half of the child participants (n=27) closed the loop, continued to trace the causal relationships around the loop, and described the behavior of the feedback loop, noting that the oscillating behavior continues to “bounce off each other” over time (degree of impact is added). Only two children reached Level 4 by describing the behavior of a balancing and a reinforcing loop. The increase in animal population in the story is the clearest reinforcing loop that the children could notice. Although children were clearly aware of population growth, it was determined that this reinforcing loop relatively remains in the background of the responses of children. As a result of drought or a flood in another region, the animals gathered around the water hole, which is the focus of the book. This behavior caused an increase in the number of the animals around the water hole, and it also increased the possibility of the addition of new members through increased birth rates. Since the story visually stood on the balancing loop, the children did not go beyond the visible level and did not focus on population growth, which is one of the root causes of the problem, while they were dealing with causal relations. There are only two exceptions in this regard. Ben Alex (A-GR), who presented sophisticated responses to most of the systems thinking aspects that this study focused on, said he would take control the number of animals by hunting some of them to solve the water scarcity problem presented in the story.

4.2.4 Big Picture Thinking

Systems thinking encompasses perceiving the whole, or, in other words, looking at the big picture (Richmond, 1994). This is a field of study which helps people to comprehend the interrelationships and structures of change, as an opposition to snapshots of scenes (Forrester, 1992). In the current study, the children were asked “what was this story about?” and to “give the book a title” to measure their ability to comprehend a given issue from multiple and holistic dimensions. However, it is important to admit that the findings related to this part of the research require cautious interpretation because the children’s responses to those questions did not provide very meaningful insights.

As displayed in Table 16, four children either did not respond to these two questions or gave irrelevant answers. For example, one child gave the name “Ella” as a title for the book. Twenty-two children provided responses to both questions that focused on one dimension in the story, such as “the story is about the water” and “title of the book can be the animals” (Level 2) because they focused only on the resource or the users in the story. When a child provides problem-oriented or habitat-oriented or a combination of user-and-resource-oriented responses, then this response was considered as a multi-dimensional perspective. Fifteen children gave responses that were evaluated as partially multi-dimensional because they provided one multi-dimensional answer to one of both of the questions. For example, according to Özcan (M-TR), the story is about the water hole and the title of the book could be “The Dehydrated Animals”.

Table 16. Big picture thinking

Characteristics	**Frequency**	**Percentage**
Level 4-Full multi-dimensional perspective	5	9.6%
Level 3-Partial multi-dimensional perspective	19	36.5%
Level 2-Uni-dimensional perspective	24	46.2%
Level 1-No response	4	7.7%

N=52

Five children displayed advanced skills by providing two multi-dimensional responses to both of the questions and demonstrated a relatively more holistic perspective toward the issues. According to Gustav (M-GR-M), the story is about “animals want to drink water but they can’t achieve this”, and the title of the book can be “The Drought”.

4.2.5 Understanding System Mechanisms

Systems thinking requires an understanding of a system structure that involves the components and interrelationships between those components (Arnold & Wade, 2015). In order to become a systems thinker, one is supposed to comprehend this structure and how it facilitates system behavior (Ossimitz, 2000; Richmond, 1994). A question which may seem very simple but also can provide very significant insights is prepared in order to reveal how a system functions generally, and what is the effect of the addition of a new component on the whole system is. In order to perceive the child participant's views on how the system could be affected if a new component was added to the system, the question “What would this story be like if people were included in the story?" was asked. From the responses obtained, the aim was to detect the children’s viewpoints on the “dynamic, complex and interdependent nature of the systems” (Anderson & Johnson, 1997, p.18) and in which situation their “balancing short-term and long-term perspectives” (ibid) skills are apparent. As can be seen in Table 17, this question was not clearly answered or was answered irrelevantly by 11 children.

Table 17. Understanding system mechanisms

Characteristics	**Frequency**	**Percentage**
Level 4-Unexpected Impact	1	1.9%
Level 3-Broader Anticipated Impact	20	38.5%
Level 2-Limited Anticipated Impact	20	38.5%
Level 1-No change or no answer	11	21.2%

N=52

Twenty children were able to display limited understanding of the system mechanisms in that they could only anticipate a potential local impact of adding the new component to the system; e.g., humans will use the water, they will scare the animals or they will take care of the animals. Nonetheless, noticing that systems consist of inter-connected components is significant. When a difference occurs in any component or relation, this influences the system completely (Thwink.org, n.d.).

Another 20 children described the wider impact of adding the new component to the system, stating that people would be included in the system as an additional user of the water. Accordingly, they will drink/use the water and this will lead to a further decrease in water:

> Investigator: ... Well, what would happen if people entered the story?
> Yakup: Then, they would drink water with a glass or a cup.
> Investigator: Then what would happen?
> Yakup: The water would go again (M-GR-L).

System behavior is an emergent phenomenon (Arnold & Wade, 2015). Accordingly, it is expected that children will acknowledge the possibility of unexpected changes in the system. Only one child considered the possibility of unexpected changes in the system:

> Investigator: ... Well, what would happen if people entered the story?
> Luka[10]: The amount of the water would decrease.
> Investigator: Then, what would happen?
> Luka: There would be one less tree in the forest because trees also need water (M-GR-L).

[10] It is found important to note that there were three child participants with similar names. The names of those children are Luka, Luca and Lukas.

4.2.6 Problem Solving

Often when we face a problem, we seek a quick way to resolve it. Although the problem might be resolved for a while with our immediate solution, it may also cause new problems and even worsen the original problem (Sweeney, 2001). Systems thinkers do not create quick or easy formulas to find leverage points (Meadows, 1999). By recalling the decreasing and disappearance of the available water, the children were asked the question "how would you solve this problem if you were one of the animals in this story?". Rather than being a third-party helper, children are asked to identify themselves with an animal in the story and find a solution to the inadequate water amount problem. Forty of the children presented valid responses to the question presented but 12 children either left the question unanswered or offered irrelevant responses (Table 18).

Table 18. Problem solving

Characteristics	Frequency	Percentage
Level 4-High Leverage of Interventions	6	11.5%
Level 3-Low Leverage of Interventions	22	42.3%
Level 2-Doing Nothing	12	23.1%
Level 1-No or Irrelevant Response	12	23.1%

N=52

Twelve children explained that it was not necessary to do anything because the water would come back anyway. Twenty-two children provided responses that were categorized as "low leverage of interventions" because they provided a quick fix approach to the problem, such as increasing the amount of water or reducing or suspending water consumption. Those children were not aware that those solutions would create new problems. One of the most popular solution proposals presented by the children was to expand the carrying capacity of water using different methods:

> Investigator: ... if you were one of these animals, which one would you like to be?
> Kerem: Mmm...... The turtle
> Investigator: What would you do if you were one of the turtles in this story? How would you prevent the disappearance of water?
> Kerem: Hmm...I would bring water back.
> Investigator: How would you bring it back?
> Kerem: I would open my mouth when it rained, collect the rain with my mouth, and carry and put the rain drops here [in the water hole] (M-TR).

Another example of increasing the carrying capacity is as follows:

> Investigator: ... if you were one of these animals, which one would you like to be?
> Louisa: Tiger
> Investigator: What would you do when you were one of the tigers in this story? How would

you prevent the disappearance of water?
Louisa: Ehm. Well! I would spit.
Investigator: Would you spit so that there would be more water? Will water be sufficient for everyone in this way?
Louisa: Ehm. Hmm... I would also set up a water faucet and let water pass through it.
Investigator: How are you going to do it?
Louisa: I'd build a stack first, then I'd put a pipe in it (M-GR-M).

Another popular response which was categorized as a "low-leverage intervention" was preserving resources by reducing or suspending the consumption of the water:

Investigator: ... if you were one of these animals, which one would you like to be?
Luka: Tiger
Investigator: What would you do when you were one of the tigers in this story? How would you prevent the disappearance of water?
Luka: I would close the hole.
Investigator: The hole in the water and what will happen then?
Luka: So the beaver at the bottom would not get water anymore.
Investigator: Hmm.
Luka: Or we would stick a piece of glass.
Investigator: A piece of glass into the water hole?
Luka: Yes. Ah, we cannot stick it in the water, it will not dry. Anyway, animals should not drink from this water hole (M-GR-L).

Six children provided solution proposals which were scored as "high-leverage interventions" because those responses demonstrated a longer term diagnostic approach by focusing on the possible root causes (reinforcing feedback loop) or by offering more sophisticated intervention points, such as acting in time before the water fully dried up (being aware of the delay in the system) or distributing the resource fairly. Luca's response is a good example within the context of acting mindfully and is related to the time dimension of systems thinking because it has the aim of acting before the water runs out: "Before the water was completely exhausted, I would gather all the animals together and we would discuss together about who could help us" (Luca, M-GR-M).

Ben Alex was able to comprehend the reinforcing loop in the system and provided solution to the problem accordingly:
"I would hunt some animals, so the number of animals that use the water would be reduced (Ben Alex, A-GR). He was the only child who intended to control population growth to find a solution to the given problem situation.

4.2.7 Hidden Dimension: Looking Beyond the Surface

Exposing hidden dimensions of the system by recognizing components, processes, patterns and relationships which are not readily seen is one of the characteristics of the systems thinker (Ben-Zvi Assaraf & Orion, 2005a). Connecting the obvious with the hidden allows better understanding the system structures, and this provides an opportunity to develop lasting solutions which are integrated into the whole system rather than short term solutions (The Donella Meadows Project, n.d.). In order to explore the abilities of the children to look beyond the seen, they were asked these five different questions: Where did the water come from? Why has the water decreased? Where did the water go? Where did the animals go?, and Who/what else needs/uses water?

As displayed in Table 19, the responses of six children were categorized at Level 1 because they only mentioned the obvious components and processes. Twenty-two child participants' responses were labeled as having a lower level of hidden components (Level 2) because they were only able to identify up to two hidden components while providing responses to the above-mentioned five different questions. Fifteen children identified more than two hidden components, and their hidden dimension ability was labeled as having a higher level of hidden components. Only 11.5% of the children mentioned possible hidden processes, and they were scored within the Level 4-Hidden Processes category.

Table 19. Hidden dimension

Characteristics	Frequency	Percentage
Level 4-Hidden Processes	9	17.3%
Level 3-Higher Level Hidden Components	15	28.8%
Level 2-Lower Level Hidden Components	22	42.3%
Level 1-Obvious Components and Processes	6	11.5%

N=52

In order to provide more insight to the abilities of children in terms of hidden dimension, responses provided to those five questions were also analyzed. Focusing on the question of "why has the water decreased" (Table 20), the children were asked to provide possible reasons for the gradual decline of the water. Nine children stated that they did not know the answer to the question, and another two children said that the water was running out because the pages of the book were turned. Three children submitted more than one justification, and in total 44 valid responses were obtained. The most popular of the children's responses to the question was that the water was drunk by animals (32 responses). The second most frequently reported response was that the water went underground (four responses), followed by three children that said that water might have evaporated and two children stating that water decreased because it did not rain. Two children thought that water was pulled down by something at the bottom of the water (one child said this was a beaver and the other one said it was a magnet). One child thought that a fire in the forest caused the gradual decrease of the water. Thus, according to the data in this section, it appears that the children's responses are dominantly above-the-surface-oriented. This means that the children were focused on the obvious event of drinking the water. As it will be presented later in this chapter, the children were dominantly preoccupied with clear events rather than the hidden levels of the system. This results in direct effects on other elements of the systems thinking because seen events often do not tell the whole story. Systems thinking makes us stop and look beyond the surface to see how the mechanism steers the patterns of behaviors that we see.

Table 20. Why has the water decreased?

Codes	Frequency	Percentage
Because it was drunk	32	72.7%
Since it went underground	4	9.1%
Evaporated	3	6.8%
Due to the lack of rain	2	4.5%
Something in the bottom (beaver and magnet) pulls the water down	2	4.5%
There may have been a fire	1	2.3%

Number of valid responses = 44

In order to reveal the abilities in the hidden dimension, children were asked where the water pictured at the beginning of the story might have come from. Twenty children (38.5%) did not give a valid response to this question. Furthermore, two of the 32 children gave two answers to this question; thus, a total of 34 responses were evaluated. As displayed in Table 21, valid responses were collated in three codes: from rain water, from another water source, such as sea-ocean-lake, and from underground. The most frequent valid response was rain water with 18 responses (52.9%). Nine children stated that water came from another source such as the ocean, the sea or lake, and seven children said that it came from underground.

Table 21. Codes-Where does the water come from?

Codes	Frequency	Percentage
Rain	18	52.9%
From another resource such as the ocean. the sea or lake	9	26.5%
Underground	7	20.6%

Number of valid responses=34

Concerning the question about where the water may have gone in relation to the hidden dimension, 40 children gave responses related to the story, a further six children gave responses that were not related to the story but which can be considered meaningful (for example, one child thought there was no water left due to a fire and another child thought the water was taken and carried to a pool), and six children said, “I do not know” or remained silent as displayed in Table 22.

Table 22. Where did the water go? Valid response distribution

Characteristics	**Frequency**	**Percentage**
Number of children who provided valid responses	40	77%
Number of children who did not provide valid responses	6	11.5%
Other (irrelevant with the story. but meaningful in general)	6	11.5%

N=52

Table 23 gives the children’s responses classified into five groups. Since two children offered two responses to this question, the total number of valid answers was 48. The most frequent response was “the water was drunk by animals”. Some of the children replied to this question by saying, “to the belly of the animals”, which was also scored under the code “drinking”. Eleven children stated that the water went underground. One child said that the water disappeared due to evaporation, and another child stated that the water went to the sea. Six children's responses were evaluated under the code of “other responses”. As mentioned above, these answers included the response that a fire may have occurred or that the water may have been transferred to a pool through the water hole.

Table 23. Codes-Where did the water go?

Code	**Frequency**	**Percentage**
Drunk by animals	29	60.4%
Went underground	11	22.9%
Went to the sea	1	2.1%
Evaporated	1	2.1%
Other responses (irrelevant to the story but meaningful in general)	6	12.5%

Number of valid responses=48

When the story comes to the page on which the animals are not visible, the children are told “... the animals have gone” and then the question “where might the animals have gone” was posed. Twelve of the children gave irrelevant answers or left the question unanswered. The valid responses to the question concerning where the animals had gone were divided into three codes. The most frequent response was “to another place where water exists” (animals went to their homes with water, another forest with water, a new water hole, or another country with water). The responses of 34 children (85%) were evaluated under this code. Five children stated that the animals went to their homes or the forest, but they did not establish the relationship of the water with these places. One child stated that the animals went to investigate the source of the water.

In order to reveal other possible hidden users of the water, the child participants were asked, “who else or what else needs/uses water”. There are two main objectives behind asking this question. The first goal is to detect children's skills of revealing the hidden components that use the same resource, and the second is to prepare a foundation to ask the question, “what would happen when people enter the story?”

As displayed in Table 24 below, sixteen children, approximately one-third of the participants, stated that they did not know the answer to the question of “who else or what else needs/uses water” or kept silent. Some children responded to this question with more than one component, and a total of 61 valid responses were received.

Table 24. Codes- Who or what else needs/uses water?

Code	Frequency	Percentage
Human beings	29	47.5%
Plants	19	31.1%
Non-living objects	5	8.2%
Soil	4	6.6%
Earth	2	3.3%
Rain	1	1.6%
Sun	1	1.6%

Number of valid responses= 61

As expected, the most frequently mentioned component requiring water was people with a frequency of 29. The second most frequently mentioned component was plants with a frequency of 19. It is important to note that the children very rarely used the word plant; they used the words flowers and trees instead. There were also children who offered unconventional responses to this question. Five children said that non-living objects like faucets, pools, and kitchens need water. Soil was also among the hidden components that use water. Below is the conversation with three of the children that gave this response:

> Investigator: What else or who else do you think needs or uses water?
> Louisa: People
> Investigator: People, what else?
> Louisa: Hmm ... Hmm... Flowers
> Investigator: Flowers, yes flowers also need water, you are right, and what else?
> Louisa: Soil.
> Investigator: Why or what does it need water for?
> Louisa: Ehm, to be able to breathe (M-GR-M).

> Investigator: Who else or what else needs water?

Simya: We need it; we cannot wash our hands if there is no water.
Investigator: Anything else?
Simya: We cannot take a bath.
Investigator: Anything else?
Simya: We cannot wash our face. We cannot drink water.
Investigator: Who or what else needs or uses water?
Simya: Imm...Soil.
Investigator: How?
Simya: If there is no water, the soil will dry and crack.
Investigator: Then, what happens?
Simya: Then, the flowers cannot grow (A-TR)

Two children stated that earth needs water. Below is an extract from the interview of one of these children:

Investigator: .... What else do you think need water other than animals?
Lukas: People, too.
Investigator: We humans also need water. What else?
Lukas: Hmm. The earth (M-GR-M).

One child gave the sun and another child gave rain as the components which need water.

4.2.8 Time Dimension

As Sweeney (2001) articulated, systems thinkers see time in a very different way from most people. Many living systems do not display the full cycle of their behavior within short time periods. As this viewpoint develops, only observing the current state of the behavior of the system is not sufficient, and it will appear that past behavior and the possible future behavior must be included. Keeping this approach in mind, evidence was sought regarding the horizontal time dimension of the system by focusing on the children's interviews, especially on the parts in which the solution proposals were explained. The findings of the current study revealed that only a limited number of children approached time from a horizontal viewpoint. As already mentioned, a significant part of the solution suggestions of the children consisted of quick fix examples. The children mostly exhibited a short term symptomatic approach, which eroded the capacity for fundamental solutions. Of two children exhibiting a long-term diagnostic approach, one focused on the past as one of the root causes, and the other was very aware of the delay, concentrating on the idea of bringing users together to intervene in time and developing a solution proposal together.

In order to contribute to the evaluation of the time aspect of systems thinking, the children were asked to predict what might be happening in the story. The main aim of the assessment in this part was to detect the children’s ability of prediction, use of short-term and long-term time intervals, and understanding; in general, how the system functions over time.

As shown in Table 25, one-third of the participants (n=16) were either unable to continue the story or provided irrelevant responses such as, “If the animals drink all the water they will become round like a ball, then they cannot see anything and they cannot walk” (Marley, M-GR-L).

Table 25. Time dimension-future prediction

Characteristics	**Frequency**	**Percentage**
Level 4-Messes Perspective	0	0%
Level 3-Broader Time Dimension	8	15.4%
Level 2-Limited Time Dimension	28	53.8%
Level 1-No or irrelevant response	16	30.8%

N=52

A significant number of children (n=28) constructed their future predictions on the existing pattern; i.e., water would be consumed by the animals again, the animals will go, water will come back, and the animals will come back. Thus, the network of relationships established by the children was predictable (Level 2).

Eight children positioned the story in a larger time interval, and their responses were scored under the broader time dimension level (Level 3). Three of these children stated that the water would be consumed every time it appeared, and after some time water would be gone forever. Two of the eight children explained that the animals would be more careful this time, and that water would not end as a result of this cautious behavior. One child added another broader, unpredictable perspective to the story:

“...water comes from the ocean ... at the end of story, all the animals swim to the ocean; there is a whale here, and some of these animals were eaten by the whale...” (Lukas, M-GR-M).

In the extract above, there are some meaningful issues to be considered. Lukas stated that the water hole in the story might have come from the ocean (past), and he built a cyclic pattern within itself, explaining that the animals would go to the ocean again (future). He considered that the animals migrated to another region. He added a new component (a whale) to the story, and this component interacted with the other components in a way that is not told in the story (the whale ate other animals).

On the Thwink.org website in the section “The Key Concepts of Systems Thinking” system behavior is described as an emergent phenomenon: “…feedback loops are present, nonlinear relationships exist, behavior paths are history dependent, the system is self-organizing and adaptive, emergent behavior is counterintuitive, time delays exist, the human mind has very limited calculation abilities, etc. Once you realize how complex the behavior dynamics of even a simple system really is, you will never again assume you can look at a system and predict how it will behave”. None of the children in the current study reached that level of sophistication.

The investigator of the study correlated the existence and presence of the water with a relatively simple time order perspective; there was water, it disappeared, and then it came back. As given before in dynamic thinking aspect, 98% of the children mentioned the back-and-forth movement of water in their interviews. When a gradual dimension is added to this process and focusing on the gradual movement of the same water in a specific time interval, the participants were expected to identify and explain the change as a series of individual events connected in time. This study revealed that 75% of the children were able to recognize the gradual decrease of the water. However, only 7.7% of the children processed the behavior of water over a longer period of time and perceived it within the circular movement dimension. These children were able to identify and explain the continuous pattern of change/trend over a specified period of time of a distinct system component. The children who established a cyclical relation had adopted a more holistic perspective by connecting the behavior of water, either with the past or the future. In this step, the children were expected to demonstrate an understanding that some of the presented interactions within the system took place in the past, while future events may be a result of present interactions.

Adopting an approach of looking time in a more horizontal way leads to the conclusion that it is necessary to ferret out delays (Sweeney, 2001) because the discontinuity in a closed system occurs from the delays between the cause and the effect. To put differently, a delay occurs when time lapses between actions and resultant feedback. As Ray Stata explained in Massachusetts Institute of Technology Sloan Management Review (1989), delays importantly impact our decisions and outcomes. Realizing a possible delay in any system is the first stage in benefiting from an opportunity to create leverage. According to the findings of the current study, only five children's responses showed a clear awareness of the delay in the system. Included in this category were the children that expressed the need to take action before the water is exhausted as in the following extract from an interview:

> Investigator: ... the water will decrease even more each time, as you said, the animals continue to increase too. How would you solve this problem?
> Lentje: I would immediately go before the water was exhausted.
> Investigator: Hmm, where would you go?
> Lentje: To another puddle (M-GR-L).

The findings of this study indicated that young children do show some signs of complex understanding regarding systems thinking in terms of detecting obvious gradual changes, two-step domino and/or multiple one-way causalities, as well as describing behavior of a reinforcing loop. However, their capacity was found to be limited in detecting a reinforcing loop, understanding system mechanisms which acknowledges the unintended consequences, detecting hidden components and processes, demonstrating multi-dimensional perspective, solving the problem through high-leverage interventions, and predicting the future behavior of the system.

4.2.9 Score Distribution According to the Different Variables

In this part of the study, findings obtained within the framework of the following research question are presented: how systems thinking skills levels of 4- to 6-year-old preschool children in Turkey and Germany change according to age, gender, language background and parental education level?

In the current study, the highest score reached by children was 19, and the lowest was two out of 24 points. The distribution of the scores according to age, gender, parent education level and language background of the child variables are given in the Tables 26 to 29.

As shown in Table 26, the average of the scores increases with the increase of age. The scoring average of age six category was 14.12, the average score of the five-year-old group (60-71 months) was 11.77, and the average score of the four-year-old group (48-59 months) was 10.05.

Table 26. Scores according to the ages of the participants

	48-59 months old	**60-71 months old**	**72+ months old**
Frequency	17	27	8
Mean Scores	10.05	11.77	14.12

N=52

When the scores of the child participants were grouped as to gender variable, there was no difference observed in the scores (Table 4.20). As mentioned earlier, the number of boys and girls participants was very similar (27 girls and 25 boys). The average age of the girls was 61.40 months and the mean score was calculated as 11.70. The average age of the boys was 62.44 months and their mean score was calculated as 11.40 (Table 27).

Table 27. Scores according to the gender of the participants

	Girls	**Boys**
Frequency	27	25
Mean Age	61.40 months	62.44 months
Mean Scores	11.70	11.40

N=52

Concerning the educational level of the children's parents, Table 28 reveals that while the average score of the children of university-educated parents was 11.58 (average age of this group was 60.5 months) , the mean score of the children whose parents had high school or below-level education was 11.90 (average age of this group was 67.09 months).

Table 28. Scores according to the education level of the parents

	University-educated parents	**Parents educated below university level**
Frequency	41	11
Mean Age	60.50 months	67.09 months
Mean Scores	11.58	11.90

N=52

In Table 29, the score distribution of children according to language backgrounds is presented. Among the participants, 12 children were bilingual, the average age of these children was 62.08 months and their mean score was 11.66. The number of non-bilingual children was 40, the average age of these children was 61.85 months and their mean score was 11.65. It is important to remember that the parents of most bilingual children had lower educational attainments than the monolingual children.

Table 29. Scores according to the language background of child participants

	Bilingual	Monolingual
Frequency	12	40
Mean Age	62.08 months	61.85 months
Mean Scores	11.66	11.65

N=52

As a result, when the score distributions were arranged according to age, gender, parent education level and language background of the child variables, it was concluded that other variables except for age had no notable effect on the mean scores. The age variable differed, showing that as the age of children increased, the mean scores also increased.

In the next part of this findings chapter, interaction between the systems thinking skills of young children, and the educational contexts they inhabit will be presented within the framework of the second research question posed in this study.

4.3 Effect of Preschool Educational Contexts on the System Thinking Skills of Preschool Children

In this section of the study, the focus is on the second research question, "what are the interaction patterns among aspects of systems thinking skills and Turkish and German educational contexts" and the sub question "what are the key variables that define the interaction patterns among systems thinking skills levels of 4- to 6-year-old preschool children and educational contexts in Germany for developing ESD educational policies and classroom applications" and seeking answers to these questions. As indicated by Gustafsson (2017), "the case studies also usually have a double function, which is that case studies are studies of its own unit, as well as case studies of a larger group of units" (p.2). When viewed from this perspective, it is meaningful to display an interactive approach by zooming in and out of the Turkish and German Early Childhood Education (ECE) system at macro level, chosen preschools at meso level and the learning group at micro level to demonstrate a holistic approach to the contextual factors that may have an effect on children's systems thinking skills of each case (Figure 11).

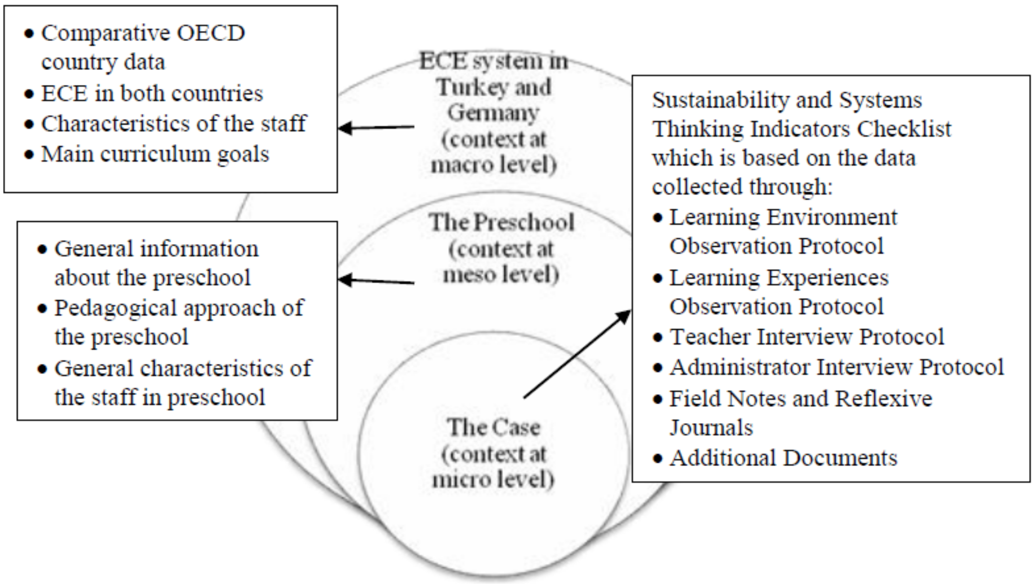

Figure 11. Contextual factors analysis levels

For this reason, firstly the Turkish and German ECE systems will be briefly described from a comparative perspective. Secondly, the general characteristics of the preschool to which the case belongs will be portrayed and lastly experiences in the chosen learning group; in other words, the case, will be described individually.

4.3.1 Description of Educational Contexts at Macro Level: Early Childhood Education in Turkey and Germany

With a view to bringing additional insight to the study, information will be included in this section on the ECE contexts of Turkey and Germany. Thus, the objective will be to clarify the general frame of ECE including statistical data, teachers' profiles, and the ECE curriculum. Furthermore, it will be explained whether and how Education for Sustainable Development (ESD) as impacted the ECE programs in these two countries. Tables 30 and 31 define the ECE context in Turkey and Germany from a comparative perspective using OECD data:

Table 30. Enrolment rates of 3- and 4-year-olds in Turkey and Germany

	Enrolment rates	2012	2005	Rank among OECD countries and partner countries*
TURKEY	3-year-olds (in early childhood education)	5%	2%	36 of 37
	4-year-olds (in early childhood and primary education)	19%	5%	38 of 38
GERMANY	3-year-olds (in early childhood education)	91%	82%	10 of 37
	4-year-olds (in early childhood and primary education)	96%	93%	12 of 38
OECD AVERAGE	3-year-olds (in early childhood education)	70%	64%	-
	4-year-olds (in early childhood and primary education)	84%	79%	-

* Countries are ranked in descending order of values.
Source: This table was produced by retrieving data from OECD Country Notes on Education at a Glance in 2014 (OECD, 2014a and 2014b)

Table 31. Comparison of Turkey and Germany according to different indicators related to Pre-Primary Education

	Turkey (2011)	Rank among OECD countries and partner countries*	Germany (2011)	Rank among OECD countries and partner countries*	OECD average (2011)
Annual expenditure per student (in equivalent USD, using PPPs) Pre-primary education	2412	33 of 36	8351	9 of 36	7428
Total expenditure on educational institutions as a percentage of GDP	4%	37 of 37	5%	31 of 37	6%
Total public expenditure on education (As a percentage of total expenditure)	11%	25 of 34	11%	24 of 34	13%

Table 31 cont. Comparison of Turkey and Germany according to different indicators related to Pre-Primary Education

	Turkey (2011)	**Rank among OECD countries and partner countries***	Germany (2011)	Rank among OECD countries and partner countries*	OECD average **(2011)**
Share of private expenditure on educational institutions (pre-primary education)	18%	14 of 33	20%	12 of 33	19%
Ratio of students to teaching staff (2012)	21	6 of 31	12	19 of 31	14
Number of hours of teaching time per year (for preschool teachers in public institutions)	1080	11 of 28	796	21 of 28	988
Ratio of pre-primary teachers' salaries to earnings for full-time, full-year adult workers with tertiary education (2012)	1.09	5 of 25	m	m	0.80

* Countries are ranked in descending order of values.
m: data is not available
Source: This table was produced by retrieving data from OECD Country Notes on Education at a Glance in 2014 (OECD, 2014a and 2014b)

4.3.1.1 Early Childhood Education in Turkey

In recent years, Turkey has recognized the critical role of early lifecycle investments. Accordingly, Turkish policymakers decided to consider ECE expansion as a way of having a strong and positive impact on the increasing population of young children. Hence, Turkey launched the Strengthening Pre-school Education Project with the technical support of UNICEF and financial contributions from the European Union. However, the quality of ECE remains as a challenge since there is no system in existence to measure learning outcomes for different age groups. In Turkey, early childhood education services are provided through education centers offering pre-school education programs include crèches (age group 0-36 months) and kindergartens (age group 36-72 months). As shown in Table 4, approximately 5% of 3 year-olds and 19% of 4-year-olds attend pre-primary education. In Turkey, most women with at least one child aged 3 to 5 years old do not participate in the labor market (only 21.4% are employed compared to the OECD average of 64.3%, 2009), showing that they stay at home to care for their children (OECD, 2013). The central government allots public funding for operational and personnel costs, such as staff and teaching material, from the national budget to public and private institutions (for students in special education) in pre-primary, primary and secondary education.

As shown in Table 5, in Turkey, the annual expenditure per student in pre-primary education is 2412 USD, which means Turkey is in the 33rd place out of 36 countries in the OECD and partner countries. Furthermore, Turkey has the lowest total expenditure on educational institutions as a percentage of GDP indicators among the OECD and partner countries. The share of private expenditure on pre-primary educational institutions is 18% in Turkey ranking in the middle (14 of 33) of the OECD and partner countries. Considering the ratio of students to teaching staff, one of the quality indicators, pre-primary classes in public institutions in Turkey are overcrowded. According to 2012 OECD data, there are 21 students per teacher and Turkey is sixth most overcrowded pre-primary classes among 31 countries. Another quality indicator, the number of hours of teaching time per year indicator, reveals that pre-primary teachers in Turkey work 1080 hours, which is over the average. According to the ratio of pre-primary teachers' salaries to earnings of full-time, full-year adult workers with tertiary education, the former have a modest income. In relation to this indicator, Turkey is fifth among 25 countries.

4.3.1.1.1 Characteristics of the Staff[11]

The duty of training preschool teachers is undertaken by higher education institutions in Turkey. In the academic year of 1980-1981, the "Two-Year Preschool Teacher Training Program" was implemented to educate preschool teachers, and this program was changed into a four-year program performed by the education faculties of universities in the academic year of 1991-1992. Then, under the title of "Early Childhood Education Program", the program was reshaped and became a section within the department of elementary education responsible for the reform for education faculties under the control of Council of Higher Education (YÖK) in 1998.

[11] Unless indicated otherwise, all the attributable information in this section has been retrieved from Kayhan and Kılıç (2011).

In Turkey, successful graduates of four-year institutions of higher education (IHE) in child development or preschool education are qualified to be preschool teachers (*anaokulu öğretmeni* or *okul öncesi öğretmeni*). In addition to day and evening preschool teacher training programs organized by education faculties, there are also distance education programs for the training of preschool teachers. Furthermore, graduates of child development and education, nursing, and care services can become pre-school teachers by completing short preschool teacher certificate programs. There are also contract status ECE teachers who are high school graduates in child development. Thus, the teachers employed in Turkey's earlier education system have received different training and qualifications.

A high school diploma is compulsory for entry to preschool teacher training programs. Furthermore, the candidates must achieve a specified score in the university entrance exam. Then, to graduate from the program, the trainee teacher must obtain the required number of credits and successfully complete the teaching practice course. No additional graduation exam is required.

4.3.1.1.2 Curriculum Goals

The national preschool education curriculum developed in Turkey was applied as of 2013 to provide for the developmental needs of the 0-36 and 36-72 months old children within the "Strengthening Pre-School Education Project", implemented by the Ministry of National Education (MoNE) with the financial assistance of the European Union (EU) and the technical support of UNICEF. The main elements of the curriculum are that it should be; child-centered, flexible, spiral, eclectic, balanced in terms of aiming to develop the whole child, and play-based. In this curriculum, the aims are determined in accordance with the child's development fields (cognitive, linguistic, socio-emotional, self-care and psycho-motor). Thus, this document emphasizes the whole-child principle. In this sense, the learning outcomes and indicators of those outcomes were formulated according to the corresponding developmental characteristics of the children. Although an important part of the curriculum is reserved for learning outcomes, the arrangement of the physical environment, activity execution, shaping the learning of children, assessment, and evaluation are also central topics mentioned in the curriculum.

The program is as flexible as possible to allow various modalities of implementation. Parental involvement is one of the main components of this curriculum; accordingly, it includes activities that families can undertake at home. In the 2013 preschool education curriculum document, it is stated that problem-solving, communication, reasoning, decision-making, taking responsibility, awareness of the environment and consumption, and many more skills will be gained by the children naturally through play-based activities, active involvement, and the construction of their own knowledge (MoNE, 2013). In addition, there is a significant place for inclusive education within the curriculum. The purposes and influences of this inclusion, and the factors affecting its success are explained in detail (MoNE, 2013).

It should be noted that the Turkish pre-school curriculum falls short in terms of explicitly emphasizing the principles of ESD. The curriculum document only underscores that for children to develop positive environmental attitudes and behaviors, it is a perquisite that teachers should demonstrate those patterns in the first place (MoNE, 2013).

4.3.1.2 Early Childhood Education in Germany[12]

Recently, ECE has become a national priority in Germany (Action plan '*Frühe Chancen*' started in 2011), and ECE services comprise two types: Krippen that is crèche services for children under 3 and *Kindergärten* or centers for children aged 3-6 years. The federal government mainly made extra funds available and tried to encourage states to stimulate the provision of quality ECE; however, educational issues remained in the hands of the individual states (*Bundesländer*). Thus, large qualitative differences between the ECE services can be observed across different states in Germany. Furthermore, states do not set guidelines or establish rules on ECE issues and have little to say concerning educational spending levels. The subsidiarity principle in Germany means that non-profit, private organizations attach priority to the supply of services, with local authorities only being involved when private organizations cannot make provision. Municipalities, on the other hand, have an important role in executing policies. It is important to note that the federal government is not entirely absent in relation to ECE.

According to the data from Country Note published by the OECD in 2014, the early childhood education system in Germany is almost universal: 91% of 3-year-olds and 96% of 4-year-olds are enrolled in early education programs (OECD averages of 70% and 84%, respectively). Free or subsidized places are often provided for children from poor, at-risk

[12] Unless indicated otherwise, all the attributable information in this section have been retrieved from European Parliament (2013).

backgrounds. A relatively small number of pre-primary pupils in Germany attend programs in public institutions (34.9% compared to the OECD average of 68.4%), but most children attend programs in government-dependent private organizations (65.1% in private institutions, which is above the OECD average of 31.5%). Many of these private programs are provided by religious institutions. The annual expenditure per student in pre-primary education is 3351USD, showing that Germany makes a serious investment in students ranking 6th in 36 countries among the OECD and partner countries. Considering the total expenditure on educational institutions as a percentage of the GDP indicator, with 5%, the country ranks 31st of 37 countries among the OECD and partner countries. Germany bears a resemblance to Turkey in the share of private expenditure on pre-primary educational institutions. The private expenditure rate is 20% and ranks in the middle of the list (12 of 33). The quality meter of the ratio of students to teaching staff indicator shows that there are 12 students per teacher according to the 2012 OECD data. With this number, Germany creates more qualified opportunities for her students in comparison with Turkey. Generally, in Turkey, there are about 25 children in a class; if this number is exceeded, then there are two adults on duty, a teacher, and an assistant. In terms of the number of hours of teaching time per year indicator, in Germany, pre-primary teachers work for 796 hours, which is 284 hours less per year compared with pre-primary teachers in Turkey. Concerning the salaries of the teachers, no data was found for either country for the ratio of pre-primary teachers' salaries to earnings of full-time, and full-year adult workers in the tertiary education sector.

4.3.1.2.1 Characteristics of the Staff

The *Tagesbetreuungsausbaugesetz* (Childcare Development Act - TAG) was implemented in 2005 to specify minimal qualification standards for childminders at ECE institutions in order to increase the level of quality. The staff in children's services are mainly female (95% in 1998). In the various types of services, 64% of the personnel are *Erzieherinnen* (the name *Erzieherin* goes back to the German term *Erziehung* – upbringing – and can be best translated as a kindergarten pedagogue). Generally, after gaining the lower secondary school diploma, *Erzieherinnen* follow three-year vocational training with either a combined internship in a center or a year of internship in the third year. In the ABL, *Kinderpflegerinnen* (literally, children's carers) play a greater role, particularly in services for children under 3. They attend a training course for two years at a vocationally oriented secondary school, and then undertake a one-year internship in a day-care center. Lastly, there are *Sozialpädagogen* and *Sozialpädagoginnen* (literally, social pedagogues) who have a tertiary level education in a *Fachhochschule.* With their higher qualification, they will probably work as leaders of centers, particularly the larger ones, but also sometimes with children with disabilities, and there are more men having this level of education.

Curriculum Goals

In Berlin, the common framework for curriculum guidelines (*Berliner Bildungsprogramm für Kitas and Kindertagespflege*) is implemented. In this document, curricular guidelines are formulated for all children attending early childhood education institutions. The document begins with an emphasis on fundamental approaches toward the education program, and children are put at the center of their own development. These guidelines are established for children to explore new things when they are pursuing their interests. Secondly, enhancing competency level of children in four basic fields is described as follows: (1) "I" competencies, (2) social competencies, (3) subject competencies, and (4) learning methods competencies. The curriculum guidelines specify six basic learning areas:

1- Health
2- Social and cultural life
3- Communication: Languages, media and written culture
4- Arts: Visual arts, music and theater
5- Mathematics
6- Nature-environment-technics

The program has a vital feature related to learning areas in which there are separate explanations given for each learning area concerning the connections of all the learning fields with one another. These learning areas are based on the competencies which are defined below. Explanations are made in the framework for every learning area and the duties of the teachers are also given. All the components of the program are connected.

In addition to the duty of focusing on learning areas, some pedagogical and methodological responsibilities and activities have been identified for teachers, and these also establish the quality indicators of the program; e.g., observation, documentation, planning the day in a holistic manner, play stimulation, project design, space and materials, integrating children with disabilities, designing the transition (transition term is used for the transition between the developmental stages of the child, transition to preschool life from family life, and transition to primary school from preschool). Another quality indicator is the strong emphasis on the central role of the parents. In this context, some suggestions are offered concerning developing a partnership between the teacher and the families of the pre-school children. These suggestions are defined more clearly with quality indicators. Finally, this program articulates the significance of the democratic concept to generate a background for communication and cooperation among the components of the whole system. This component is also made clearer through quality indicators. The outstanding themes in the program are inclusive education, equality, diversity, education for sustainable development, ethnic and religious values, and adopting a quality approach to education.

Berliner Bildungsprogramm has a special chapter on ESD, which mentions the Brundtland Report and defines ESD. It also emphasizes the argument that preparations for a sustainable future begin in the early ages. Examples are given, mostly referring to consumption patterns.

The nature-environment-technics component of the curriculum states that children are born with curiosity. In this part of the document, children's perspective, their interaction with the nature and their ability on hypothesis testing by observing nature are also explained. Strong emphasis is placed on outdoor play, observation, patterns and processes of the nature and attachment with nature. In addition, having an egalitarian approach towards gender in all these periods and stressing the need for approaching girl and boys in an equal way while working on nature-environment-technics area are explained.

In the next section of the findings chapter, each cases will be presented individually at meso and micro levels because "qualitative analysts are obliged . . . to make sense of individual cases" (Sandelowski, 1996, p. 525). Attention was paid to follow the order of the visits while reporting. It is suggested to refer to the Systems Thinking Developmental Rubric (Appendix B) for K-Level and the Sustainability and Systems Thinking Indicators Checklist (Appendix D) while reading the case narratives.

4.3.2 The Mainstream Education Case from Turkey (The M-TR Case)

4.3.2.1 Description of Educational Context at Meso Level: The M-TR Preschool

4.3.2.1.1 General Information about the M-TR Preschool

M-TR preschool is located in Levent, one of the business centers of Istanbul. This preschool has been providing ECE services for approximately 50 children every year since 1985. The physical space of the pre-school comprises approximately 275 m² closed space and an open area of about 250 m². The preschool building consists of one floor and an attic space. The first floor consists of three rooms and a communal area, children's toilet, and a kitchen. In the attic, there is a warehouse-style room and a large activity room. The children receive education and care services in three different groups according to their age and in a classroom assigned to each group. In the morning, afternoon and towards evening, the children gather together in the common area called "the hall" for activities, such as free play, morning sports, and dance. One of the classrooms is used as a dining room at noon. There is a playground with slides and swings in the open area and a poultry house with ducks and chickens inside. During the observation period, children were never taken to the garden with the cold weather being given as an excuse. This preschool describes the ECE service mission as follows:

"We aim to arouse the child's interest with different activities in a framework of an educational program to help children to concentrate their attention, to use the things they learned when they need, and to be happy when doing these activities" (Website of the institution)

Unlike other cases, the children remain with the same teacher throughout their preschool education. For example, upon entry to the school, the child is assigned to a three-year-old group with a teacher, and this child engages in the ECE process with the same teacher for about three years until the end of their preschool education. In this regard, it is concluded that the teachers who work in this preschool do not have any specific expertise either within an age group or discipline.

4.3.2.1.2 Pedagogical Approach of the M-TR Preschool

Based on an examination of many different pedagogical approaches, it was determined that M-TR does not have a pedagogical approach. The pedagogical descriptions received from the preschool administrator and the teacher were short in terms of details, and the preschool's website and brochures consist of features that can be considered only as a generic. For example, the website of the institution states: "Our education program is based on an approach that incorporates elements from many programs, such as project-based learning and GEMS (Great Exploration in Math and Science)". Both in the classroom observations and the interview with the group teacher, there was no support for this description of the program. For example, when explaining the pedagogical approach in the interview, the group teacher did not mention GEMS. Contrary to the project-based learning approach, the teacher said: "I do not like to remain on the same subject for a long time. I do not like to discuss the same subject for a month because I want to cover different subjects and activities" (M-TR, Teacher).

As written in the web site of the preschool, the education in this learning context is based on the following basic principles;

- Being child-centered and placing creativity on the front-line
- Focusing on versatile development and flexibility
- Attaching importance to environments that allow children to have free experiences
- Emphasizing problem-solving and game methods
- Encouraging the use of everyday life experiences and close environment
- Attaching importance to family participation
- Providing versatile assessment
- Using process-oriented assessment methods, such as portfolios

As a result of the observations and the interviews, it was concluded that there was little evidence of most of the principles given above being put into practice. The structure of M-TR is adult-centered, hierarchical, and the possibility of the children being autonomous is almost absent. Furthermore, the preschool has no relations with the neighborhood in which it is located.

Like many commercial preschools in Turkey, English language education is one of the learning areas the preschool emphasizes: "In our playgroup, English language education is applied for 20 minutes daily, and in the four to six age groups, English is acquired in a natural learning environment and spread over the school day" (Website of the institution). However, in practice, this was not the case. During the observation period, over a week, the learning group came together with English teacher twice, and during this period, a reading and singing activity of about 20 minutes was conducted.

An Orff music tutor from outside the school meets with this learning group once a week. The institution's website states that within the scope of the music class the aim is to give the children an opportunity to express themselves through rhythm and movement using various musical instruments and to develop their creativity. In the website of the institution, it is stated that the children regularly engage in a cooking workshop: "Every Tuesday, our children, wearing tiny kitchen aprons, prepare their own food, such as cakes, muffins, cookies, and other food to have in their mid-afternoon snack time. In this process, they reinforce the concepts of measurements and science, and they are thrilled to work as a team” (Website of the institution). During the observation week for this research, the cooking workshop was not undertaken. The last component of the pedagogical approach focuses on training and exploration trips: “In parallel with the subjects we are working on, we organize trips at least once a month so that the children can carry out research and investigation, establish cause-effect relationships, and develop inquiry skills” (Website of the institution). A field trip was held during the week of observation. Within this trip, the children went to an activity center. In this center, a children's book author read aloud the book she had written and signed a book for every child. An accordion recital was presented to the children during the event. There appeared to be no link between the content of this trip with any learning experiences designed in the preschool.

4.3.2.1.3 Characteristics of the M-TR Preschool Staff

The owner of the preschool, who is also the preschool's administrator, has about 30 years of experience in the ECE field and undertakes general administrative duties in the school. In the preschool, children are divided into three learning groups according to their age, and there is one teacher in each group. One of the teachers has 15+ years of professional teaching experience, and the other teachers are in the first 10 years of their profession. There is also an intern assigned to the youngest age group. The other staff of the M-TR preschool are a housekeeper and a cook.

4.3.2.2 Description of the Case

This part of the thesis presents the characteristics of the participants and the contextual description of the M-TR case within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.2.2.1 Profile of Child and Adult Participants

Table 32 and Figure 12, show that five girls and seven boys from this preschool participated in the study, and were mostly monolingual Turkish speakers. At least one parent of each of the children had completed university education. The mean ECE enrollment age of the children was 39 months.

Table 32. Profile of child participants from M-TR case

	Characteristic	Frequency	Percentage
Gender	Girls	5	41.7%
	Boys	7	58.3%
Age	48-59 months old	7	58.3%
	60-71 months old	5	41.7%
	72+ months old	0	15.4 %
Bilingual	Yes	1	8.3 %
	No	11	91.7%
Education Level of One of the Parents	University degree or above	12	100%
	Less than university degree	0	0%
Mean ECE Enrollment Age: 39 months old			
Mean Age: 57 months old			

N = 12

The mean age of the child participants from the M-TR case was 57 months. The gender and age distribution of the children are given in Figure 12:

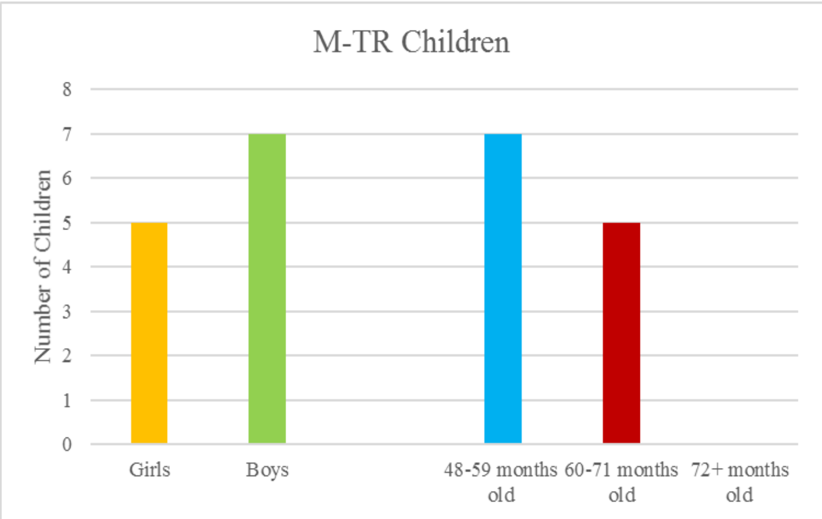

Figure 12. Gender and age distribution of children from Case M-TR

Two female adults from the M-TR preschool participated in the study; the administrator and the teacher of the selected case. The administrator of the preschool is 45 years old. She is a high school graduate and has worked in the current preschool for 20 years. The teacher of the M-TR learning group is 27 years old, is a high school graduate, and has worked in the current preschool for six years. At the time of the research, these two women had teaching experience of 19 years on average and their average age was 36.

Next part of the thesis presents the contextual description of the M-TR case within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.2.2.2 Preschool Climate

In the first part of the checklist, the preschool's internal dynamics and the level of communication with the outside world are given under the section on preschool climate. As shown in Figure 13, M-TR does not fully satisfy any of the six criteria described in this section; two criteria were partially met and four were not met.

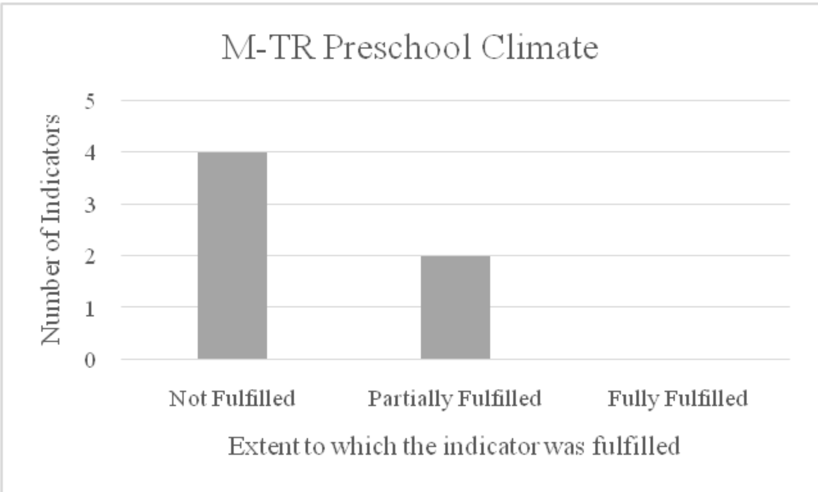

Figure 13. Preschool climate in M-TR

The indicator referring to ‘opportunities for administrators, teachers and parents to have a say and be involved in all issues and themes that affect them are supported by institutionalized participation structures’ was not fulfilled in this case. Most of the decisions were taken by the preschool administrator, which means there is a top-down approach in the whole preschool. According to the curriculum of the preschool, a different theme is studied each week, and the administrator is involved in determining these themes and their contents. Similarly, it was observed during the application phases that the activities were supervised by the administrator, and she regularly enters classrooms and sometimes interacts with teachers and children. The administrator described the children’s perception of her role in the preschool as follows: “The children are aware that I am an authority. I do not want to mean authority actually. Well, they know I am in a different position” (Administrator, M-TR).

The decision-making process concerning how many pages of child portfolio would be delivered to family members was evidence of the top-down approach mentioned above:

> We are always discussing and talking about how many pages the portfolio presentation will have. We take decisions altogether because my teachers are the ones who implement this practice and I know that they will not abuse this. So, they never decide on their own. Together we make the right decision and this makes our work easier. For example, if a New Year decoration is prepared and sent home with the children, we decide together on what to choose. I research it and find one which is easier to make (Administrator, M-TR).

The indicator referring to ‘adults act out democratic forms of conflict resolution in the preschool’ was not fulfilled. A significant part of the decisions about the daily flow in preschool is taken by the administrator as mentioned above, and a significant part of the decisions about the flow in the class is taken by the teacher. Families are generally involved in matters that concern only their children. It was understood through the interviews with the administrator and teachers that the adults tried to solve their own conflicts among themselves. The indicator referring to ‘children act out democratic forms of conflict resolution in the group’ was also not fulfilled in this case. No evidence was found on the existence of a democratic structure in the preschool in terms of conflict resolution among the children.

The administrator organizes team meetings when necessary, and in this respect, it was concluded that the indicator referring to ‘staff feedback and consultation sessions take place regularly’ was partially fulfilled. According to the administrator, the new generation of teachers are generally not equipped with adequate professional skills and always need a guidance: “...So you need to tell them what they need to do. They do not think about their profession too much” (Administrator, M-TR). In-service training is generally conducted by the preschool administrator: “In fact, I am not that assertive about in-service training. I'd better push the teachers a bit on this issue. We mostly conduct in-service training together. I tend to transfer the things I gained from training seminars to them” (Administrator, M-TR). Hence, the indicator referring to ‘there is a comprehensive approach to staff development and training’ was not fulfilled.

The M-TR preschool is considered to be located in an isolated part of the neighborhood. The teacher of the learning group openly stated that they had not executed any kind of activities in the surroundings of the preschool. The only activity that is undertaken in this context is the trips organized intermittently. A teacher who mentioned that the children went on a trip to the fire station was asked why this activity was carried out, the teacher stated, “because the fire department is eye-catching, and there is red color all over the place". At a later stage of the interview, it was understood that this trip was carried out within the scope of the occupations covered in the curriculum and an educational link was established in this way. In that sense, the preschool cooperates with individuals, organizations, and authorities outside the school in order to open up external spaces for experience and learning, albeit in a limited way.

4.3.2.2.3 Physical Space

One of the seven indicators discussed under this heading was partially fulfilled and six were not fulfilled (Figure 14).

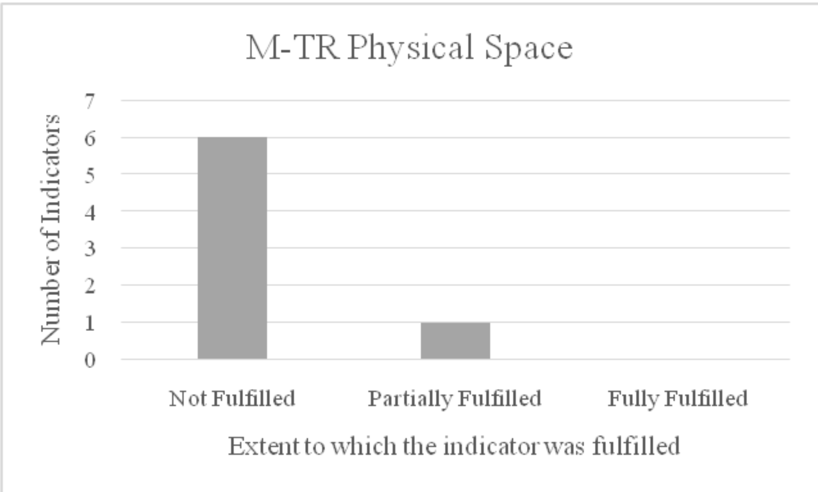

Figure 14. Physical space in M-TR

As noticed in the A-TR preschool, the building of M-TR was designed to be used for residential purpose but had been made suitable to accommodate a preschool. The children in the M-TR case spend a considerable amount of time at the preschool in a 40-square-meter attic area that has been converted into a classroom. At certain times, children also have access to the shared space of the hall and the dining room; thus, the children did not have access to most of the parts of the indoor environment. Throughout the observation period, the children were not allowed to use the outdoor environment of the preschool under the excuse of the weather being cold. The investigator and her partner examined the outdoor environment of the preschool and realized that some parts of the garden were also closed off with a fence; therefore, the children did not have access to most of the parts of the outdoor environment. There are chickens, roosters, and ducks in the garden of the preschool. The animal pens and small pools of ducks are located behind the garden. Since the classroom is in the attic, it has a dim atmosphere illuminated by light from two small windows and fluorescent lamps. In the classroom environment, there were remarkable material limitations in that except for a few wooden toys, wooden blocks, and toy cars, most of the materials belong to the category of stationery materials such as scissors, glue, and cardboard. The only play materials that the children can freely access in the classroom are shown in Figure 15.

Figure 15. Play materials in the classroom

A significant part of the play materials is kept in cupboards away from the classroom, and teachers occasionally take materials out for the children to use. Administrator stated the following in terms of the toys: “For me, the diversity of the toys is important, but there should not be too much stimulus around children. So, we have big cabinets upstairs, and a large number of our toys are in these cabinets. We change the toys in the classroom from time to time” (Administrator, M-TR).

In the hall, there were interest corners, where children spend some of their free time playing (Figure 16). However, it was concluded that in the M-TR preschool in general and in the classroom of the M-TR case, there were not abundant materials that the children could use in many ways.

Figure 16. Interest corners in the hall

It was also noticed that the shared space, namely the hall, was congested as can be seen in Figure 17:

Figure 17. Children in the hall

On toy day, children were allowed to play freely with their own toys and class materials. Apart from these opportunities, it was concluded that the indicators referring to children have space and time to use the materials were not fulfilled. However, there were plenty of education sets in the classroom; for example, handwriting education set, scholar fruit education set, easy and fast primer set, pre-school education set with games, intelligence cube education set, and Ton Ton education set (Figure 18).

Figure 18. Preschool education sets

Systems are partially illustrated in the learning environment. Posters, which are parts of the education sets described above, are hung on the walls of the classroom. These posters have themes such as organs and vehicles; however, since they are only on wall display formats, the children are unable to touch and manipulate the systems.

4.3.2.2.4 Approach to Learning and Experiences

There are six indicators discussed in this part of the report. M-TR did not fulfill two of these indicators, partially fulfilled two, and fully fulfilled three (Figure 19).

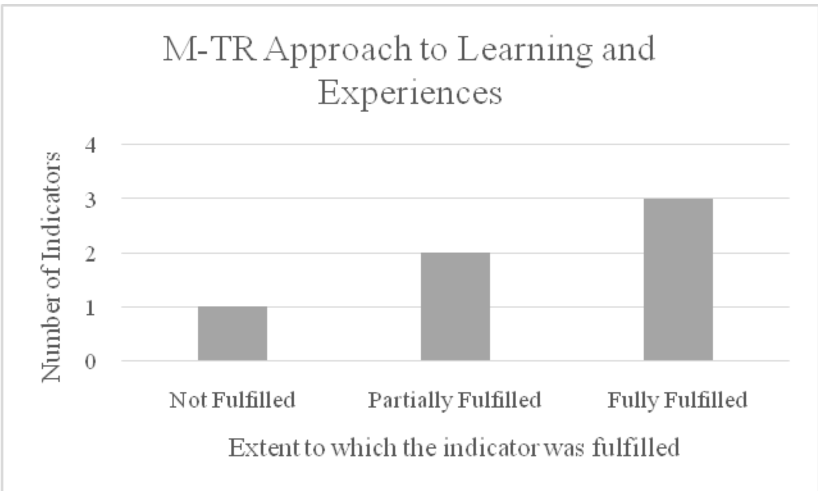

Figure 19. Approach to learning and experiences in M-TR

In the M-TR preschool, the curriculum is thematically structured and has a spiral nature. For example, the theme witnessed during the observation week was penguins and chosen by the adults. This theme was handled through different dimensions in the three learning groups in the preschool. This fact was confirmed in the interview with the teacher who said: “the penguin subject was presented to this group in the past years. So, they know this subject very well” (Teacher, M-TR). The activities conducted on thematical basis are not addressed over a long period as in the project-based approach. The themes are presented and completed in one week. In conclusion, in this learning environment, the learning experiences are partially linked to other learning experiences generally at the subject-spanning level, and deep project-based learning was not utilized.

A one-week lesson plan designed for M-TR is as follows:

<u>First day</u>

Artwork: Painting penguin drawings and creating a story with these pictures

<u>Second day</u>

Mathematics Activity: Counting the components in two sets, resulting in judging whether or not the sets are equal, placing the emperor penguin and other penguins in appropriate sets

Artwork: Making penguins with play dough

<u>Third day</u>

Trip (which has no connection to penguins)

<u>Fourth Day</u>

Science Study: Freezing of water-filled glasses to observe the transformation of liquids into solids, or vice versa, observing the melting of frozen water

<u>Fifth Day</u>

Drama Study: Developing a story and animation related to the life of penguins

In the process, a book on penguins was also read to children, and they were given some information about the life of penguins. As explained above, although the learning experiences in M-TR were designed to be multi-disciplinary, no binding learning experiences were found to provide an inter-disciplinary transition. In this sense, an important part of children's learning experiences are multi-disciplinary, yet not fully interdisciplinary. In this context, basically, the information about penguins was presented by the teacher asking a question and the children answering.

Documentation partially enables the children to observe their own learning processes over time. In the M-TR preschool, portfolios including children's work are prepared twice a year. The main purpose of this study is to make children's learning experiences more visible to their parents rather than deepening their learning. As discussed earlier, this educational context is adult-centered, and decisions about how many pages of the portfolio should be displayed and which studies should be exhibited to parents are taken by adults. Moreover, the teacher checks the work of the children and activities; then, if there are "missing" or "untidy" things, the teacher corrects them. From this perspective, it is concluded that this type of documentation will not lead the children to engage in higher-order thinking as defined in the process of metacognition.

4.3.2.2.5 Thinking and Acting Routines

There are 12 indicators under this heading, of which none was fully fulfilled; five indicators were only partially fulfilled and seven were not fulfilled at all (Figure 20).

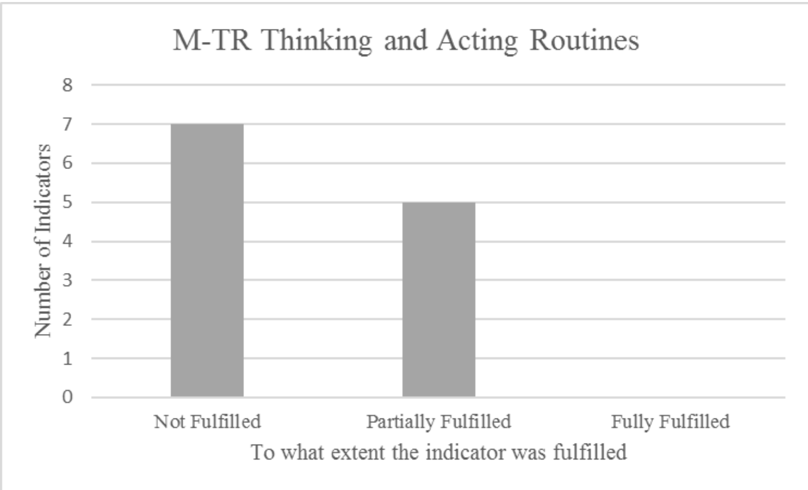

Figure 20. Thinking and acting routines in M-TR

Subject-matter knowledge is one of the areas that was carefully observed in this learning environment. The questions directed to children were generally in the form of recalling information; thus, it was concluded that the teacher of the learning group did not ask cognitively challenging questions. The questions posed to the children were mostly of a matching perception type (Level I) and selective analysis/integration of perception type (Level II). There were a few questions at Level III noticed by the researchers:

> The children were able to respond to questions, such as what kind of animals are penguins, how are they born, what do they eat, where do they live, why do they shamble, can they fly, why do they carry their eggs, where do they accumulate their food, why do they accumulate

> their food, how they make sounds, do they swim fast or slow, how many offspring do they have etc. (Field Notes, Research Partner).

The children of the M-TR case have a busy agenda and pass from one activity to the next at a great pace: “All of the children have their own workbook. The teacher quickly looked through the exercises, often giving the answers herself without waiting for responses from the children, telling them to put a cross there, circle this, etc.” (Field Notes, Research Partner). In addition to this busy tempo on weekdays, homework is also assigned for children at weekends. The teacher puts a star sign on those who completed their homework, and those who did not were warned: “If you do your homework, you will have a bright future, if you do not, I do not know” (Teacher, M-TR). In this period, some of the children became tired. In a drawing activity, when one of the youngest children said that his hand was tired, the teacher responded: “Unfortunately, you cannot get tired; you will always have to write when you attend primary school. You have to get used to it. The more you draw, the more your hands will become accustomed to it” (Field Notes, Investigator).

Children could talk freely but in a limited way; yet, as mentioned, the time spent together was used for completing the pages of the workbook and the planned activities, and there was not much time assigned for practices like experience sharing. For example, during the book reading about a penguin, some of the children wanted to ask questions but the teacher said that they could not ask a question while she was reading the book; they could only ask after the reading had finished. Furthermore, both during the supervised activities and free-play times, children were not able to converse freely with the teacher and among themselves. A child who was engaged in the activity and talking at the same time was warned: “Egemen, can you concentrate on your activity, please? You will go to other schools in the future, you should not go there without having practiced. We will have portfolio presentations soon and we need to prepare for it” (Teacher, M-TR).

Adults partially created opportunities for a circle of viewpoints. Different ideas were discussed within the learning group but in a very limited way. The aim of the questions asked by the teacher was to recall knowledge rather than laying the ground for the discussion of different ideas. The investigator and her research partner concluded that only one deep topic in the morning circle was seen throughout the observation period. At this time, the question, "what is responsibility?", was posed, and each child was asked to produce an opinion. This was difficult for the children, and the teacher asked the question in different ways so that the children were able to produce some ideas about the topic.

The teacher of the learning group was very busy all the time, and she only partially listened for and encouraged children's thinking. The adults in the preschool did not create open-ended experiences to foster creativity; rather, every activity conducted with children contained intense directives:

> Paper with the outline of a penguin was distributed to children for them to color the picture. The teacher distributed one orange and one black crayon to each child, sharpening some of crayons, if needed. Then, the teacher told the children that the beak of penguin should be painted in orange, and their back should be black. The teacher warned the children to hurry with the words, "come on, be quick" and examined the coloring of the children, completed the incompletely colored pictures, and colored in a significant part of the paintings of those children who had not worked so fast. Those who finished sat on the cushion in the classroom. When all the children had finished, they sang the penguin song[13] together. The teacher showed the work that one child had done the day before. This child was considered by the teacher as being behind his peers, and the teacher said to the other children that they will do the same activity. After all the children completed their work, the teacher distributed circles of blue cardboard and foam pieces to the children. One of the children asked the teacher where she had found these materials, and the teacher replied, "I did my research and found them". The teacher glued certain parts of the cardboard. She asked the children use their hands to break up the foam pieces into snowflake shapes, and then to stick the pieces onto the glued parts. One of the children asked, "could this be a snowflake shape?" The teacher replied, "whatever you like, it is your activity". Immediately afterwards, she said to another child, "your work is not what I want; you should split the foam into smaller pieces", and then to the other, "your work is not okay, you should stick on some more snow". When there was not enough foam on the children's cardboard circles, the teacher filled gaps and warned the children who talked to each other, "we did not come to the preschool to chat, we came to study and learn" (Field Notes, Investigator).

This extract from the field notes reveals that activities were carried out with a perfectionist approach, and any shortcomings in the activity were completed or corrected by the teacher. As a result, the children's work was almost the same (Figure 21):

[13] **Lyrics of the Penguin Song:**
You only shamble, you cannot run, but
You are a beautiful swimmer, but you cannot fly, but
You do not get cold on ice
You never stop singing, you don't keep quiet, but
Penguin penguin come to us
My mother cooked a fish for you

Figure 21. Outputs of an activity completed before the observation period

The children of this group are divided into two groups according to age, and in some cases, different activities were assigned to each group. It does not appear that the basic reason for this classification is to create deeper understanding of issues in which the adults partially focus on individual children or small groups. There were no wrap-up or reflection exercises at the end of the activities.

The indicator pertaining to adults displaying flexibility while creating learning opportunities was not fulfilled in this case. The themes utilized in the preschool were prepared within the framework of the educational plan that was created for the school year. The same theme is applied to every age group, and the activities are planned by the teachers in advance. The adults in the preschool do not provide the children with the space to participate in decision-making processes in line with their age and abilities. During the whole observation week, children's ideas were only asked regarding a single topic, and their decision was not taken into consideration as shown in the following extract from the field notes:

> The teacher asked the question, "children, our activity is finished. Shall we go out and play in the garden now or play free games in the class?" The vast majority of the children wanted to go out. The teacher told the children that it would be better for them to have a free play session in the classroom because the weather was cold but they could apply their decision in the afternoon; however, children remained indoors all day (Field Notes, Investigator).

The adults in M-TR do not encourage children to do things for themselves, and the educational context is not designed to allow children to meet their own needs. There is a sense in the preschool that children need constant adult supervision. The activity materials are distributed by the teacher and collected by the teacher when the activity is finished. There is no role for children in the day-to-day functioning of the school, and even some practices that children can do on their own are undertaken by adults; for example, when they were going on a trip, some of the children are dressed by the adults.

The indicator referring to 'free play is extensively encouraged by adults' was not fulfilled in this case. The children were not allowed to extensively engage in free play; they were only able to play for a short time until morning activities started, after lunch time, and in the afternoon when activities were over. Evidence regarding the approach of the adults toward free play is reported in the incident detailed below:

> We made a field trip to an activity center to meet an author of children's books. She read to the children from the book she had written; we listened to music. When the event was finished, the children were taken to the garden of the activity center where we waited for the minibuses to take us back to the preschool. In the garden, there were large trees and a lot of dry leaves on the ground. The children ran towards the dry leaves, and when they started throwing the leaves into the air, the adults intervened saying, "It's the time for everyone to stand with their backs to the wall and form a line". All children were pushed into the queue, photographed, and returned to the preschool in the minibuses (Field Notes, Research Partner).

The consistent attempt to keep almost every movement of the children under control was noted by the investigator and her research partner in the reflexive journals as follows: "After some of the children had their books signed, they had a chance to run for a short time in the garden, and children were excited with the dry leaves and immediately began to play. But the teachers intervened and put the children in the queue". The reactions of the researchers in their reflexive journals were: "Actually, I find this very sad" (Investigator). "I could not understand why the children could not play freely with the dry leaves for a short period of time" (Research Partner).

4.3.2.2.6 Focus on Sustainability

There are nine indicators under this heading, seven of which were fully fulfilled and two were partially fulfilled (Figure 22).

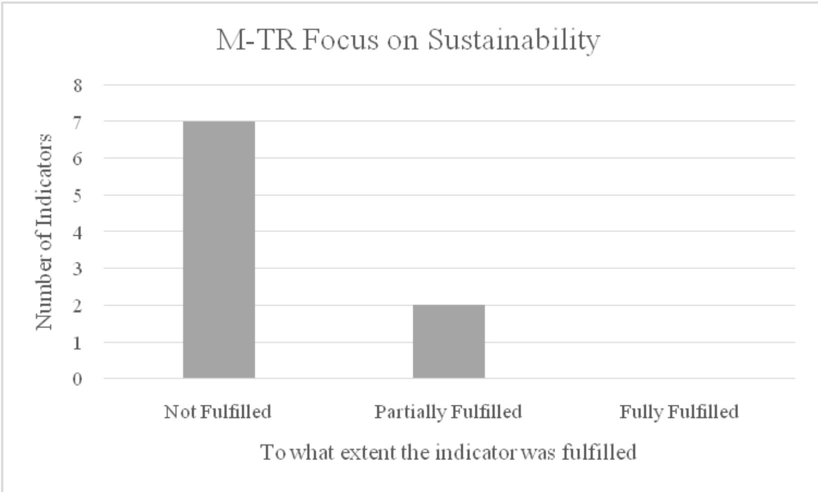

Figure 22. Focus on sustainability in M-TR

The practices of the M-TR preschool were not in agreement with the theories and concepts of sustainability. Neither the preschool administrator nor the teacher was aware of the theories and concepts of sustainability. Consequently, sustainability topics were not integrated into the internal preschool teaching plans and curricula. The experiences that children had in the context of sustainability were just artificial ecological activities held in the spring and summer months. During this time, the children were involved in the care of the ducks, chickens, and cocks that are reared in the coops in the garden of the preschool. The preschool administrator stated that she and the other teachers had not received any pre- and/or in-service training in the field of ESD, EE and EfS, and this was confirmed in the interview with the teacher.

The indicator referring to ‘purchasing policies for supplies, equipment, and food are based in equal measure upon environmental and social sustainability and on economic viability' was not fulfilled in this preschool. Some of the food consumed in the school is obtained from the preschool administrator's farm outside the city, and the remainder is obtained from the supermarket. In the supply of toys and stationery materials, it was attempted to purchase quality products which have minimal damages to health. There was no further data about purchasing policy was presented to the investigator of the research.

‘The preschool carefully manages the resources by reducing, reusing and recycling’ indicator was partially fulfilled. There was no systematic approach to waste management in the preschool. The materials were used as carefully as possible, with some of the waste materials being reused in the activities; however, the main reason is economy, rather than protecting nature.

The adults in the preschool did not present a definition of the term "diversity" in a multi-dimensional way. According to the learning group teacher, diversity is the different methods and materials that she uses to enrich the subjects she presents. A similar definition emerged in the interview with the preschool administrator:

> When we say "diversity", to excite children comes to my mind. Just break the monotony for a little bit. One day in the summer, we moved all the school into the garden for example. We took the toys out, put some cushions on the ground to make the environment a little different. Because none of us like monotony, and this stimulates us (Administrator, M-TR).

The cultural backgrounds and socio-economic status of the people in the school are similar, so there is no substantial opportunity to appreciate a rich cultural diversity in this sense; additionally, cultural diversity is not on the agenda of the preschool. This means that the indicator related with the cultural diversity was not fulfilled in this case. The animals in the garden were the only evidence regarding the indicator referring to the 'adults provide children with the opportunity to learn, appreciate and compare diversity in nature'. Accordingly, it was concluded that this indicator was fulfilled partially.

The behaviors of adults fell short in terms of showing acceptance of the differences in people. Many comments made by the learning group teacher to support this conviction: "Eda, your hair is so beautiful, and I love girls who tie back their hair like this. Damla, why don't you tie your hair back?" and "Yes, Ali[14] pushes people sometimes. I think he learned this at home. He does it here too, but he will learn not to do it" (Teacher, M-TR). Judgmental statements about Ali's behavior were often expressed by the teacher. Moreover, it was witnessed that the children copied the teacher and they talked about Ali in a judging way. In the activity of sticking penguins on the blue cardboard with foam, the teacher said that she and Ali made a sample the day before after other children had gone home. Then, activity materials were distributed to all children, and while the children were engaged in the activities, the teacher suddenly recalled that Ali had already worked on it and took back all the materials she had given him.

[14] Ali is the child who was labelled by his teacher as "the child who is behind his peers".

4.3.2.3 Systems Thinking Skills of the M-TR Case Children

This part of the case study narrative specifically focuses on the evidence found in an educational context that can be related to the Systems Thinking Developmental Rubric for K-Level. In this regard, the level distributions in each aspect of each of the children in the case are presented in Figure 23.

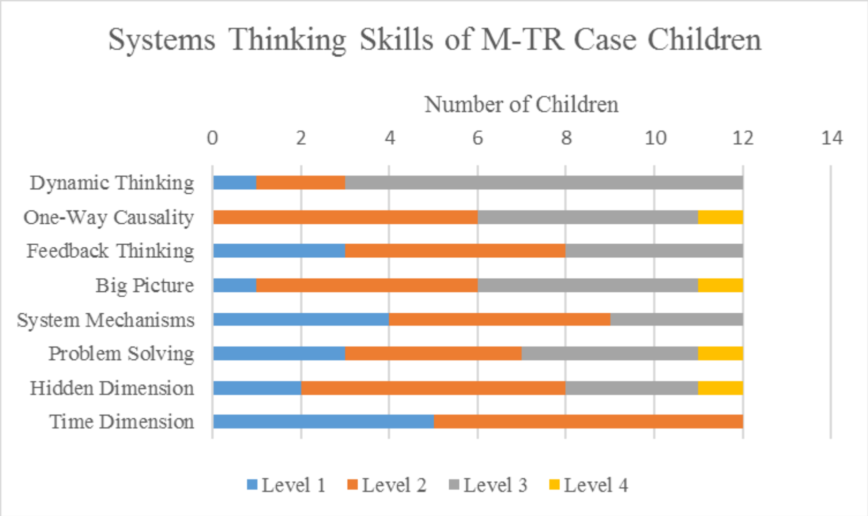

Figure 23. Systems thinking skill levels of children from the M-TR case

In this part of the study, 17 indicators are evaluated. M-TR did not fulfill eight of these indicators, partially fulfilled five, and fully fulfilled four (Figure 24).

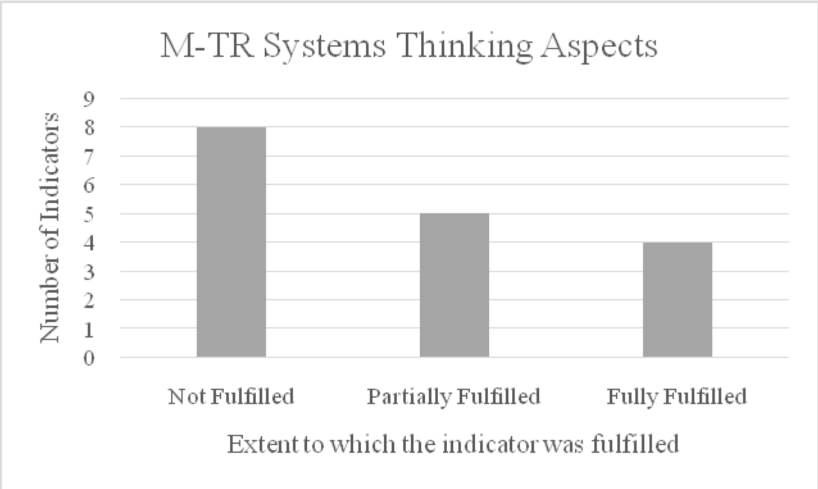

Figure 24. Systems thinking aspects in M-TR

4.3.2.3.1 Dynamic Thinking

In this aspect of systems thinking, the aim was to detect the children's dynamic thinking ability concerning whether they could understand changes in the components and processes that construct the obvious and hidden patterns in the system. There are some previous practices in this preschool which supported the children in solving the pattern in the book that was discussed in this study and allowed them to comment on the gradual change in the amount of water. The indicators referring to 'there are educational materials concerning the use of mathematical reasoning exercises such as numeration, pattern building and discrimination of size' and 'the children practice mathematical reasoning experiences such as numeration, pattern building and discrimination of size' were fully fulfilled in this case. Many pattern building and numeration exercises were observed in the workbooks of the children and the numerous other educational sets in the classroom. Mathematical reasoning is one of the areas that are strongly emphasized in this learning environment, supported by the many educational sets and visuals in the classroom on this subject (Figure 25). However, it is important to note that those materials were only available in paper formats.

Figure 25. Evidence regarding mathematical reasoning activities

As shown in Figure 23, the children from M-TR performed mostly at Level 3 in dynamic thinking. The response of one child was evaluated as at Level 1, two children as at Level 2, and nine of the children responded at Level 3. None of the children from this case could provide an answer that was related to Level 4. The only child who performed at Level 1 belongs to this case; she had the lowest total score among all child participants and was one of the youngest child participants (49 months old).

4.3.2.3.2 One-Way Causality

In this aspect of systems thinking, the aim was to assess the connections that children made in the story about water considering whether they detected the domino causality and multiple causality, as well as the direct and indirect connections. The children from M-TR generally performed at Level 2 and Level 3. One child performed at Level 4, and she described an extended linear pattern that includes a multi-step linear connection of three or more steps with indirect effects:

> Eda: When there is no water how will people live?
> Investigator: I don't know. What will happen when there is no water?
> Eda: We cannot wash our hands. They will be dirty. The microbes in our hands will make us sick.
> Investigator: Is that true?
> Eda: Yes, we will be ill. We will cough and sneeze. We can go to the doctor, and he will heal us.

During the period of observation in the M-TR case, there were a few activities that could be associated with one-way causality dimension:

> When the morning circle was held, the teacher opened the window and invited the children to stand in front of it. She asked the children the following questions: "How is the weather today? Do you think this air is clean or dirty? Do you see the smoke over the buildings? How do you think this smoke is formed? Is it windy today? How did you know it is windy? Do you think that animals are having difficulty in finding food in this cold weather? What can we do to help animals? (Field Notes, Investigator)

Other evidence of causal relations was found during morning sports. The teacher gave a skipping rope to each of the children and asked the following question: "Why do we skip?" The children responded: to have fun, to work out our arms, to jump, to play sports, and to be strong. These examples reveal that the quality of the one-way causality activities was generally poor, and accordingly, it can be stated that the children were engaged in one-way causality experiences, but the indicator referring to this skill was only partially fulfilled.

4.3.2.3.3 Feedback Thinking

As mentioned above, the children have a moderate linear causality background. In the feedback thinking aspect of systems thinking, the aim was to measure the children's ability to detect the behaviors in the system that can feedback on each other to form positive and negative processes. Given the feedback loop in the story, evidence that will correspond to the statement patterns like 'the more, the more', 'the less, the less', 'the more, the less', and 'the less, the more' was sought for in the field work, and a single piece of evidence was found within the teacher's comment, “the more you draw, the more your hands will become accustomed to it”. It is also important to note that this sentence was not an example of closed-loop thinking; accordingly, it was concluded that children were not engaged in closed-loop thinking practices. Three children, in this case, were not able to close the loop and performed at Level 1. Five children closed the loop by not specifying quantities, and four specified the quantity while closing the loop.

4.3.2.3.4 Big Picture Thinking

This aspect focused on measuring the children's ability to demonstrate a multi-perspective approach and comprehend a given issue from a more holistic perspective by responding to questions, such as ‘What was this story about?’ and ‘What could the title of the book be?’. In the interviews and observations, it was concluded that in the book reading activities, the children were not asked these kinds of questions.

In this aspect, one of the five children corresponding to Level 4 belongs to this case and she provided two multi-dimensional responses to both questions and displayed a relatively more holistic approach to the issues belonging to this case. According to Ela, the book is about the forest, and the name of the book could be “forest animals”. In the M-TR case, one child was at Level 1, five children performed at Level 2, and five performed at Level 3.

4.3.2.3.5 Understanding System Mechanisms

For this aspect, the aim was to determine the children's understanding of system mechanisms by adding a new component to the system. Four children stated that there would be no change in the system and were categorized as at Level 1. Five children described only the potential local and short-term impacts of adding the new component to the system. Three children described the wider and long-term potential impacts of adding the new component to the system. There was no child who considered the possibility of unexpected changes in the system. Tools that can help to give high-level answers to this type of question include exercises, such as talking about a system in detail or asking ‘what happens if we remove this component or add this component’ when undertaking causality practice. No such tools were in evidence in the M-TR case.

4.3.2.3.6 Problem Solving

The children's problem-solving ability in a given problematic system behavior was determined in this aspect of systems thinking. In the context of problem-solving, there is a conclusion that children have very limited experiences in this educational context. In the observation process, for solving a problem, the clearest example was the conversation based on the questions of "do you think animals are having difficulty in finding food in this cold weather?" and "What can we do to help animals?". In the interview conducted with the preschool administrator, it was stated that in the preschool they particularly focus on the children's development of problem-solving skills, but the comments referring to this context do not overlap clearly with the observations.

Both the preschool administrator and the teacher of the learning group expressed their interest in drama work in order to tackle the issues in front of them and make the problems visible to children. The administrator explains how they deal with certain issues:

> In the classroom, we tell the children that the school bus driver complains to the teacher that they do not want to wear their seat belt and they want to stand up. Then we line up the chairs and create a minibus environment. We wait at the red light, we move at the green light. We certainly do not release our seatbelts. We do not speak loudly and do not distract the driver. You know when you do it with drama and play, children learn it better and the learning becomes permanent. (Administrator, M-TR)
>
> Investigator: Are there any special things you do for children to develop their problem-solving skills early on?
> Teacher: I often carry out drama activities. Let's say we have an incident; for example, two children have hit each other. We talk to the teachers; then, we pretend that we are the two children who hit each other. We wear different clothes, we change ourselves, and we behave like children. We handle the issue in this way.

In this educational context, the children are not challenged with problem situations. All the issues that can be considered as real-life problems are mostly handled by adults. Decisions are taken by adults; every step is planned and controlled; thus, there was a lack of opportunities for the children to encounter real-life problems. However, there were some exceptions in conflict situations between children. When the children told the teacher about this situation, the teacher said that they must solve their problems among themselves. In conclusion, children partially encountered real-life problems, and accordingly opportunities were partially provided for the children to solve problems on their own.

In terms of the problem-solving question asked of the children within the scope of the research, three answers were evaluated at Level 1, four at Level 2, four at Level 3 and one at Level 4. There was one response from this case suggesting a fair distribution of resources as a solution to the problem (Level 4). In the context of the Level 3 responses, two children provided responses in the scope of preserving the commons by reducing consumption, and two children gave an answer that can be evaluated as expanding the carrying capacity categorization. Three children left this question unanswered or provided irrelevant answers.

4.3.2.3.7 Hidden Dimension

This dimension had the aim of assessing the children's ability to detect obvious and hidden components and processes in the system. In this aspect, it was concluded that two of the answers were evaluated at Level 1, six at Level 2, three at Level 3 and one at Level 4. Since this aspect is related to the root-causes thinking skill and subject matter knowledge, there are two issues to be considered. One of the possible areas of supporting the hidden component is to discuss about root causes. Conversations that are deep enough to focus on root causes when constructing cause and effect associations were not found in this case. Compared with the other cases, it was concluded that imagination is a phenomenon partially supported in this case. Drama activities were considered as evidence; however, the children mostly engaged in imagination activities during free play as shown below:

> In the older group, the children painted the snakes that were printed on the paper that was given to them. They turned to their own devices at every opportunity. Ozcan turned the paper upside down and took it to the light, “It looks like a ball from the back, and looks like a snake from the front”. While the teacher was busy with the younger group, the children hissed and played with the paper snakes as if they were real (Field Notes, Research Partner).

The second issue related to this aspect is subject-matter knowledge, which was very important in this learning environment. The children having some prior knowledge of the water cycle is a factor which makes it easy to comment on hidden components and processes. From the conversations with the teachers, it was deduced that the children had some previous educational experience of discussing the water cycle in a fragmentized way.

4.3.2.3.8 Time Dimension

For the last dimension in systems thinking, the aim was to detect the children's ability to comprehend time and make a future prediction. In order to collect data in this area, an assessment was made concerning whether the future prediction work was undertaken with the children in the field and if there were conversations about future prediction, past-present-future connection and about time in general. In the M-TR case, there was a clear evidence regarding conversations related to time. In this case, unlike other cases, regular calendar events were performed every day. Songs were sung about the days of the week, months, and seasons. They talked about what season, month and day it was. The date of that day was marked on the calendar. They underlined yesterday’s date and what date it would be the day after. The children were asked what year it would be after the New

Year’s Eve. Based upon the physical artifacts hanging on the wall (Figure 26), it was concluded that the same practices were repeated in the English class. Accordingly, it was concluded that children were involved in conversations related to time.

Figure 26. Evidence regarding the calendar activities

The past-present-future conversation indicator was only partially fulfilled in this case because those conversations were evaluated as shallow-level back-and-forth movements in time. Also, those conversations only included patterns for past-present connection, as indicated in the exercises which involve recalling information in the previous activities given to children. There was no good-quality evidence related to future prediction. In this case, five of the children's future prediction skills were at Level 1 and seven children at Level 2. Unlike other cases, none of the children from this case performed at Level 3.

4.3.3 The Alternative Education Case from Turkey (The A-TR Case)

4.3.3.1 Description of Educational Context at Meso Level: The A-TR Preschool

4.3.3.1.1 General Information about the A-TR Preschool

The A-TR preschool is located in the city of Izmir, in the west of Turkey. This preschool provides services under the private preschool status, and the monthly fee for each child is around 300 Euros. Five places are available for children whose families are in financial difficulties. Since 2009, the A-TR preschool has been providing ECE services for up to 50 children of white-collar families. The preschool defines its activities as follows: This preschool is an alternative education institution that supports learning environments in children can be healthy, happy, egalitarian, libertarian, collaborative, and able to realize their social dynamics with all their unique features. (Website of the A-TR preschool)

The A-TR preschool occupies a physical area composed of approximately 600 m² of indoor space and approximately a 600 m² open area. The indoor space consists of educational workshops designed with a dynamic system approach that will be discussed under the heading pedagogical approach. In addition to being used as a playground, the school garden is designed as a living space where children can encounter plants and flowers of various kinds. There is a mini botanical garden (Figure 27), an orchard where children grow fruit, and a compost bin. There is also a stage available for different artistic performances in the garden. Children have their lunch in a separate dining room where both ecological and non-ecological products are prepared and served fresh.

Figure 27. Botanical garden

4.3.3.1.2 Pedagogical Approach of the A-TR Preschool

The basic principles of the education program were developed using a "local" approach, following the examination of many alternative approaches and original experiences, then selecting the strengths of these experiences, which are presented below:

- The developmental potentials and creativity of the children are the most basic determinants.
- The program has a productive and dynamic nature.
- The program elements are orientated toward the idea that when children are motivated, they start to learn.

- Play is considered as fundamental in the creation of educational environments.
- The individual characteristics of the children are taken into consideration and opportunities are created in relation to these qualities.
- The aim that all the children are in contact with the strengths of all the teachers/practitioners in the preschool is based on all children being able to say, “all teachers are my teachers”.
- All the children from all age groups are encouraged to learn from and nurture each other.
- It is essential to take advantage of the dynamics of all the places in the school; therefore, every area of the school is considered as an area of activity.

In order to achieve the pedagogical approach given above in the A-TR preschool, a structure called as dynamic system[15] has been created. This is designed as an alternative to the system that exists in the mainstream preschools in which three axes of “teacher”, “grouping”, and “physical space” determine the educational framework. The dynamic system is based on the following hypotheses:

1) All teachers are my teachers

2) All children are my friends

3) Every space is my learning area

“All teachers are my teacher”

Early childhood education teachers are expected to be qualified in many areas and disciplines, from mathematics to literature, theatrical skills to agricultural knowledge. However, no single person is capable of possessing such a wide range of abilities; each teacher may be strong in certain areas and weak in other. However, because of the unique structure of the early childhood period, children should be able to use different disciplines in this period, which is required for them to undertake an extremely difficult task, that of gaining a basic understanding of the world. In pursing this aim, this preschool does not find it realistic to expect early childhood teachers to be multi-disciplinary at the top level. Rather, they adopt an approach in which every teacher in A-TR preschool conducts

[15] The information in this section was taken from the preschool's website and this information was verified by the observations performed. Information that is not confirmed by observations is not included in the descriptions.

workshops in areas in which feel they have the skills, and all children have the chance to meet all the teachers in these workshops. It is also believed that the more professionals observe children in many different areas of activity, the more comprehensive the observations will be; thus, more information about the child will be accrued.

“All children are my friends”

According to the understanding embraced in A-TR preschool, the concept of “class” in mainstream education is accompanied by the isolation of children and their families from the children of other age groups and their families. Although according to A-TR preschool, each child needs to work together and experience each other even if they have different chronological ages. Based on this reasoning, a holistic approach is important, encompassing the idea that the whole preschool is a group, which allows for the dynamism that is formed by bringing together children of different ages and at the same time there can be an exchange of experience among parents.

The stages of development are important reference points for this preschool, and it is believed that the learning processes should be organized by taking these steps into consideration. Thus, A-TR preschool has groups including children of similar ages and some developmentally-appropriate activities are applied with these specific age groups; however, this does not prevent mobility between groups of children when they wish. A-TR preschool encourages different age groups to work together and play together frequently.

“Every space is my learning field”

According to the educational approach of the A-TR preschool, spending most of the day closed in a place called ‘the classroom’ means that other facilities of the preschool remain subordinated, and moreover, unused. In the A-TR preschool, all areas including corridors, halls, balconies, and terraces are considered as educational areas and each is believed to carry distinct dynamics. The organization of the interior space is based on various workshops, such as Ecology, Scientific Thinking, Creativity and Design, Drama and Book, Art and Music. The children visit all these workshops throughout the day and are involved in the learning process. The outdoor area consists of educational areas, such as the botanical garden, log park (Figure 28), stage, garden orchard, and play park, which are open all day for the children to use.

Figure 28. The log park

4.3.3.1.3 Characteristics of the Preschool Staff

This preschool has an administrative team of three people who are also the founder partners of the preschool. Unlike many preschools in Turkey, this administrative team has important roles in the education of the children, as well as their administrative duties. For example, one member of the team is a preschool psychologist, who supports the pedagogical approach of the school, carries out music workshops with the children, and works in the school garden from time to time. Apart from the administration team, the A-TR preschool has a staff of seven teachers, a cook and a housekeeper. One member of the administrative staff and one person in the teaching staff (15+ years of professional experience) are senior educators. The remaining 6 teachers have teaching experience ranging from 3 to 10 years.

4.3.3.2 Description of the Case

This part of the thesis presents the characteristics of the participants and the contextual description of the A-TR case within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.3.2.1 Profile of Child and Adult Participants

As shown in Table 33 and Figure 29, six girls and three boys from this preschool participated in the study, and all were monolingual Turkish speakers. Regarding the parent’s education level, at least one parent of eight children educated at university, and only the parents of one child did not have a minimum undergraduate level education. The mean ECE enrollment age of the eight children was 32 months.

Table 33. Profile of Child Participants from the A-TR Case

	Characteristic	Frequency	Percentage
Gender	Girls	6	66.7%
	Boys	3	33.3%
Age	48-59 months old	5	55.6%
	60-71 months old	4	44.4%
	72+ months old	0	0%
Bilingual	Yes	0	0%
	No	9	100%
Education Level of One of the Parents	University degree or above	8	88.9%
	Less than university degree	1	11.1%
Mean ECE Enrollment Age: 32 months old			
Mean Age: 59 months old			

N=9

The mean age of the child participants from the A-TR case was 59 months. The gender and age distribution of the children are given in Figure 29:

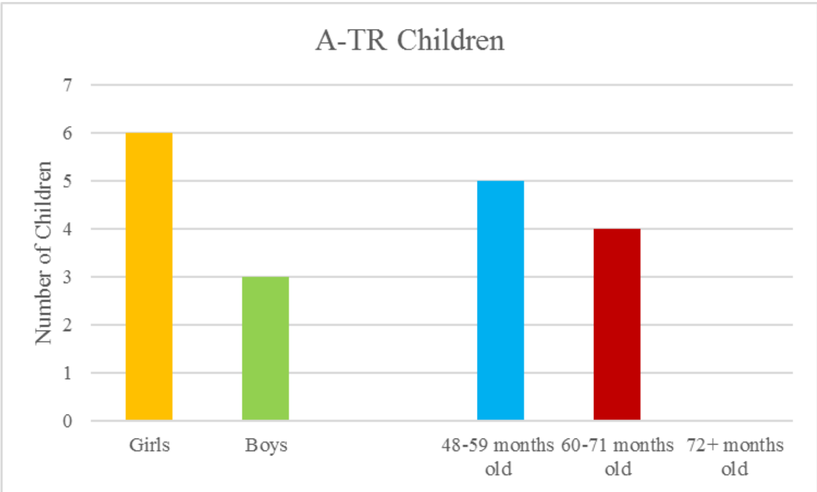

Figure 29. Gender and age distribution of children from Case M-TR

Three adults from the A-TR preschool participated in the study; two administrators and the school's most senior teacher. One of the administrators was male, and the other administrator and teacher were female. These participants all had a university degree. The female administrator had 35 years of experience in the ECE field and also worked as an instructor for many years in institutions where ECE teachers are trained. The male administrator had a psychological counseling degree and seven years of experience in his profession. The senior teacher had 15 years of professional experience. All three participants had been providing ECE services since the school was established. The average age at of the participants was 43.7.

In the following part of the research report, the contextual description of the A-TR case will be presented within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.3.2.2 Preschool Climate

In the first part of the checklist, in the section on preschool climate, the preschool's internal dynamics and the level of communication with the outside world are given. A-TR fulfilled five of the six indicators fully and the remaining one partially (Figure 30).

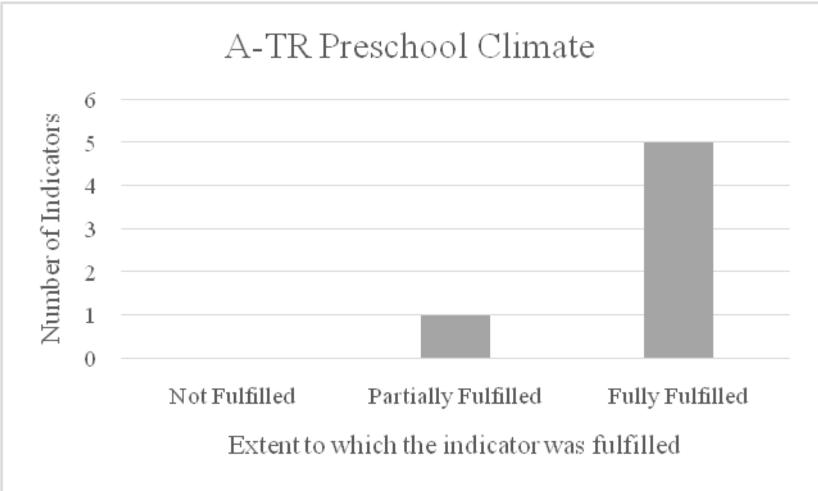

Figure 30. Preschool climate in A-TR

In this learning environment, there is a Preschool Council, in which all the employees are involved and discuss all the issues and topics that affect them. This arena also provides a suitable basis for conflict resolution. All employees can freely express their problems in this environment, which does not adopt a hierarchical approach. For issues that cannot be resolved through discussion are dealt with by the Reconciliation Commission with the participation of an impartial person from outside the preschool. There is no family or child participation in the school council; however, there is a plan to create a family council. Accordingly, it can be stated that the indicator regarding the full participation of the all adult stakeholders (administrators, teachers and parents) to the issues affecting them was partially fulfilled.

To help the children to resolve conflicts among themselves, a Peace Table consisting of a child-sized table and chairs in the common use area was prepared. Children with disagreements invite each other to the Peace Table and seek solutions to their problems. At the Peace Table, the children express their views and opinions, and if they cannot reach an agreement, another child is involved as a referee or mediator. During the observation period of this research, this practice was not witnessed but the teachers informed the researchers that the Peace Table was frequently used. During the observation, a small conflict occurred between two children, and a third child suggested, “I think they can solve this issue at the Peace Table”. Hence, children acted out democratic forms of conflict resolution in their group.

Both administrators and the teacher expressed that staff feedback and consultation sessions take place regularly. As previously reported, the preschool conducts its educational activities within an alternative pedagogical approach. In this preschool, the teachers received pre-service training in the mainstream approach; thus, the school employs only those teachers who are able to follow the pedagogical approach of the school, and then the teachers follow an intensive training program. Hence, indicator referring to ‘in the preschool, there is a comprehensive approach to staff development and training’ was fully fulfilled.

The A-TR preschool is in contact with other institutions providing alternative education. The preschool works in close cooperation with individuals, organizations, and authorities outside the preschool in order to open up external spaces for experience and learning:

> One of the topics we focus on in the school is the use of plastic bags. We had a difficult time with this issue for a while. We organized a session with the children to talk about the possible damage that plastic bags causes. In the art workshop, with their teachers, the children prepared a large fabric poster with the theme of using cloth bags instead of plastic bags. In another workshop, we made cloth bags with the children, each child creating their own original design. In another activity, we walked around the neighborhood with the children with the cloth banner and the bags. We ended up in a supermarket at the end of the march and suggested the manager avoid the use of plastic bags (Administrator, A-TR).

The children regularly visit the children's parks in their neighborhood, and there is a close communication between the park staff and children. For example, during the pruning period, park staff notifies the preschool and the children are given the opportunity to observe pruning. Mid-afternoon breakfast is sometimes organized in these parks, and the food is also prepared for park staff. During the research, an animal shelter construction workshop was observed. This workshop was designed and implemented as a parent involvement event, and aimed to help provide shelter for street animals in the neighborhood where preschool is located.

Next part of the thesis presents the contextual description of the A-TR case within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.3.2.3 Physical Space

Five of the seven indicators discussed under this heading were fully fulfilled and two of them were partially covered (Figure 31).

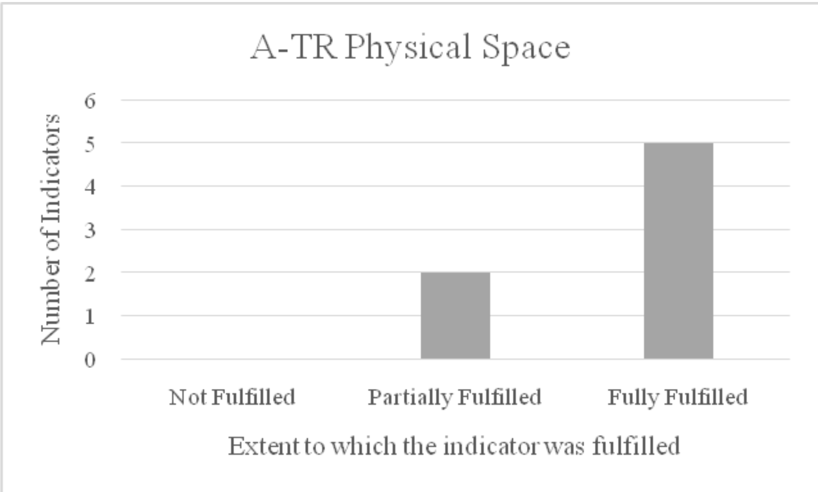

Figure 31. Physical space in A-TR

Unlike the examples in Germany, the preschools in Turkey are not generally constructed with the intention of using the building as a preschool. Mostly, the buildings which were designed as residential or workplaces are put into service by making them suitable for preschool conditions. The A-TR preschool has been transformed into an early childhood learning center by converting a building designed as a residence into preschool, and this process is thought to have been constructed with a holistic viewpoint. For example, some of the food consumed at school is raised from the seeds grown by the children. Those leftovers that are available are provided for the use of street animals. The remaining vegetables and fruit are put in the compost bin, and later the children are involved in digging the compost into the garden.

In the A-TR preschool, there are strong ideas about the use of physical space. It is argued that the classroom approach in conventional preschool education brings isolation and segregation. In accordance with the educational design in A-TR, children are expected to visit all the open and closed areas of preschool during the day. Children have access to all parts of the building in the outdoor and indoor environment, as well as the access to most of the materials. In the preschool, there is a rich and abundant amount of materials that children can use in many ways. The children are given the time and space to use the materials. A significant portion of the materials is positioned so that they can be accessed by the children.

There is no clear emphasis on systems in the learning environment. The circular journey of food, the ecosystem created by the species in the school garden, are always within the sight of children. However, physical artifacts that examine all interactions of a system with hidden and obvious components within different time periods were not encountered during the observations for this research. Therefore, systems are only partially illustrated in the learning environment, hence the children are able to see and touch the systems in a limited way.

4.3.3.2.4 Approach to Learning and Experiences

There are six indicators discussed in this part of the report. A-TR did not fulfill three of these indicators and fully fulfilled three (Figure 32).

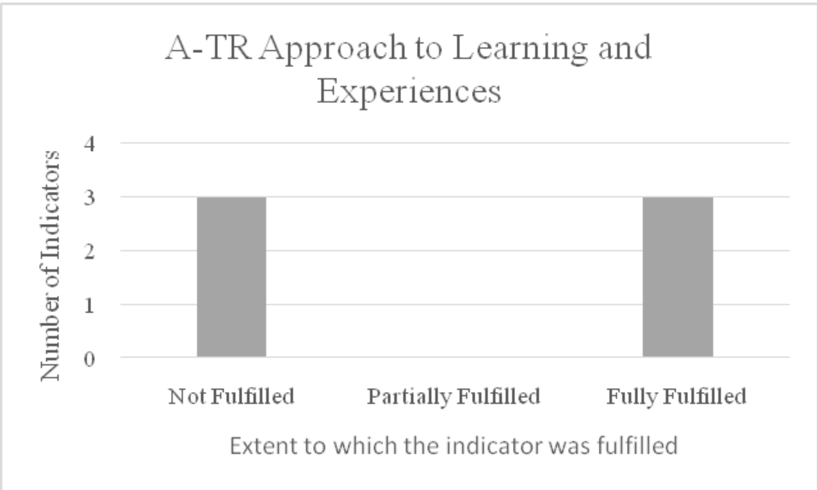

Figure 32. Approach to learning and experiences in A-TR

As a result of the observations and the analysis of the monthly plans, it was concluded that some of the educational contents of A-TR are created within a holistic structure and others were created within a fragmentized structure. The "Another World Program"[16] created by this preschool cover themes such as peace, love, labor, brotherhood, sharing, solidarity, freedom, criticism. These themes are incorporated into the educational stream at different times using different methods. Another creation of the preschool is the Scientific Thinking Program, in which there is an attempt to design holistic experiences but it is understood that this program is still in the exploration phase:

> Individual information also triggers conservatism. It's not just about freezing water; it is important to follow the whole journey of that water. The sequence of learning is important within itself. This is why the Scientific Thinking Program has consecutive activities that understand and link to each other. We try this with the children nowadays (Administrator 1, A-TR).

Each teacher designs the content of their own workshop independent of the learning experiences that the other teachers design. Moreover, the same teacher does not create mechanisms to associate learning experiences with each other in the educational design they produce. Although no data was found in the subject-spanning and project-based learning areas during the observation period, it was concluded that the previous plastic bag project is considered to be a meaningful example of deepening the learning of the children. In the plastic bag project, different dimensions of the same subject were undertaken with children in different workshops, and social action was organized in the last stage of the project. It was reported in the interviews that the children engaged in different topics which they expanded in the long-term:

> We have been running the Peace Contract for a month. This activity is valid for the whole school including the children ... We worked on the olive tree in our garden for 1.5 months ... The plastic bag issue is always on the agenda, recently the children themselves decided to make an audit and entered all the rooms and checked for plastic bags. When a plastic bag was found in my room, they had a lot of fun and told everyone (Administrator 1, A-TR).

In conclusion, in this learning environment, the learning experiences are partially linked to other learning experiences generally at subject-spanning level and deep project-based learning was not utilized.

Although the learning experiences in A-TR were designed to be multi-disciplinary, no binding learning experiences were found to provide an inter-disciplinary transition. In this

[16] "This program aims to take the first steps in topics such as being able to experience both cultural values of the society being lived in and humanistic and universal values in adult life, develop personal skills freely, consider events and phenomenon in a critical way, and being able to understand that another world is possible" (Website of the institution).

sense, an important part of children's learning experiences are multi-disciplinary, yet not fully interdisciplinary. The from-time-to-time applied projects mentioned by the administrators and the teacher are exceptions to this opinion.

The preschool has a clear view of the documentation of child development and learning. One of the preschool administrators stated that they were opposed to normative assessment tools in the context of documenting child development, and often mentioned in the interview that anecdotal records were kept by all adults in the preschool. In the interview with a teacher, it was concluded that the teachers completed a form to assist them in evaluating the developmental characteristics of the children and they prepared a development report for each child. An important part of the children's work is sent home with them. Some of them were kept by teaching staff to be used as data. Thus, it was concluded that these documentation techniques does not enable the children to see their own learning processes throughout time.

4.3.3.2.5 Thinking and Acting Routines

There are 12 indicators under this heading. In A-TR, four of these indicators were fully fulfilled, seven were partially fulfilled, and one was not fulfilled at all (Figure 33).

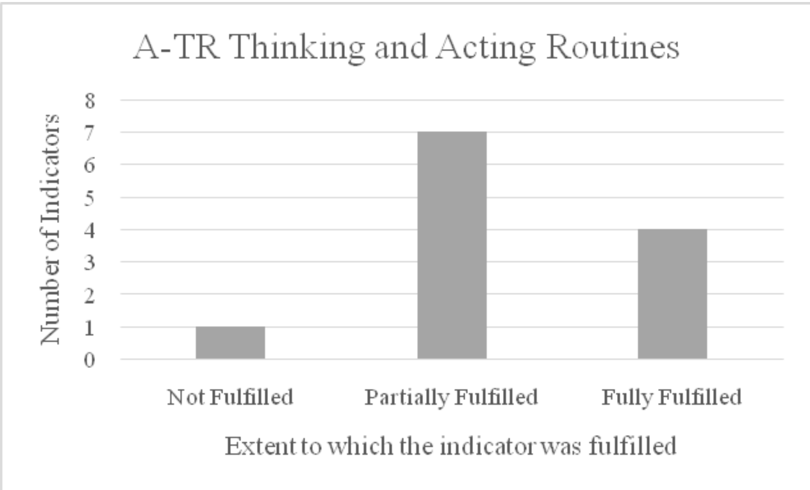

Figure 33. Thinking and acting routines in A-TR

The adults in the preschool partially asked cognitively challenging questions. The questions posed to the children were mostly of a selective analysis/integration of perception type (Level II) and reordering or inferring about perception (Level III) type. A few questions on Level IV were also noticed by the researchers:

> A picture of a young girl crying was handed out to the preschool children and the following questions were asked: "Why might the girl in the picture be crying, can you think of a reason? What may be in front of this girl? Why is this thing there? What can we say to this girl to calm her and make her stop crying? Why would you say this?" Each child expressed his/her own ideas, they gave very different opinions. In addition, children were asked to paint their own ideas on the paper illustrated with a crying child. For example, a child said that the girl in the picture was crying because her toy had been taken from her. He drew another child in front of this girl who was taking the toy from her hand. Then, another child was drawn at the back of the girl. This child was handing a ball to the crying girl. After this activity was completed, the children began to draw freely on the back of the paper. During this time, the teacher monitored the children one by one and examined the drawings on the crying young girl paper, asked the children to explain their drawings, and noted the children's explanations on their papers (Field Notes, Investigator).

As far as the observations showed, it was concluded that children were presented both closed-ended and open-ended experiences. Open-ended questions in potential open-ended activities were often asked in the preschool and opportunities for a various viewpoints were created:

> In a study carried out in the art workshop an activity was observed. There were waste plastic lids glued on a large piece of cardboard by children in another group. There were blank parts on the cardboard and the teacher asked the children, “Look, these parts are blank, what we can do here and there?” The children gave different ideas, such as “We can stick a button on, we can stick a leaf on, we can draw pictures in the empty places”. However, the teacher said, “I have a suggestion, shall we stick something plastic on here?” Then, children put their ideas aside and implemented the teacher’s plan. (Field Notes, Investigator).

As demonstrated in both of the examples presented above, children could talk freely and the adults created opportunities for a range of viewpoints. Both during the supervised activities and free-play times, children were able to converse freely with the teacher and among themselves. During those times, children asked many questions and the adults listened to and encouraged children’s thinking in an engaged way.

Adults partially created open-ended experiences to foster creativity. One of the administrators stated, “we have a specific focus on creativity because it allows children to develop a wider approach to issues. Thinking out of the box is more important than working hard. Creativity can shake the whole world” (Administrator 2, A-TR). Although the art workshop activity described above actually has the potential for a meaningful experience with an open-ended structure to design and foster creativity, the activity became a close-ended structure due to the teacher’s approach in deciding that the children would follow the teacher’s idea. In general, it was concluded that creative thinking was fostered in this learning context, confirmed by the following observation:

> A teacher entered the room with a handful of green leaves cut in half. First, she threw the leaves into the air, and after the leaves had fallen down, she said to the children, “Everyone choose a leaf, then try to find the other half of this leaf”. After this activity finished, she

> gave the children a blank sheet on which to glue one half the leaf. The children glued half of the leaf on the paper and they completed it by drawing the other half of the leaf according to the teacher's directions. Then, they drew a more free work on the back of the paper. The teacher asked the children to glue the leaves in their hands onto the paper, and then in the blank area left on the page to draw something that could include this leaf. The children transformed leaves into objects such as cat houses, planes, apples (Field Notes, Investigator).

The samples of the outcome of this activity are shown in Figure 34.

Figure 34. Children's outputs on the leaf activity

In the science workshop, activities were observed that aim to develop children's mathematical reasoning. The children worked in small groups with the materials designed by the teacher. In this process, the children were able to use peer support if necessary, and if this was not sufficient, then the teacher would help. In this activity, the teacher focused on individual children or created small groups to ensure a deeper understanding of the topic. However, it should be noted that the group-based work was heavily involved in activity designs, accordingly focusing on individual children or creating small groups for the deeper understanding indicator was only partially fulfilled in this learning environment. Wrap-up or reflection exercises at the end of the activities were not observed by the investigator and her partner.

The adults displaying flexibility while creating learning opportunities indicator was partially fulfilled in this case. The teachers conducted their workshop activities within their monthly plans they prepared. In some cases, though the application times of activities were changed, it is concluded that no substantial changes were made in the content of the activities throughout the process.

The indicator referring to adults providing the children with the space to participate in decision-making processes in line with their age and abilities was also partially fulfilled. It was concluded that as shown in the activity described above conducted with waste plastic lids in the art workshop, even though the children gave their opinions about what to put in the spaces, the teacher told the children what to do; thus, the children's involvement in the decision-making mechanisms of this activity was low. On the other hand, on one of the walls of the workshop rooms, there was evidence that children painted the behaviors they wanted to see in the school, and that these pictures were also written by the teachers through the children's narratives. This activity is part of the Peace Contract that was mentioned above. In this context, it is concluded that the children were able to contribute to the establishment of the basic principles in the school.

In general, adult supervision and the wishes of the child were in balance. In this way, adults partially encourage children to do things independently. Even though children of this age group are capable of acting independently during eating times, adults mostly supervised meal times:

> In the dining hall, all the tables were prepared by the housekeeping staff, all the meals were again served by her. Each child was given the same amount of food. For children who finished their meal and asked for more a second helping was given. The children left the dining hall after they finished the meal. The tables were cleaned by the staff (Field Notes, Research Partner).

The children engaged in free play and constructed activities in a balanced way. They were in their most autonomous situations in free play time. Hence, it was concluded that the indicator related to the free play was partially fulfilled in this case.

4.3.3.2.6 Focus on Sustainability

There are nine indicators under this heading, seven of which were fully fulfilled and two were partially fulfilled (Figure 35).

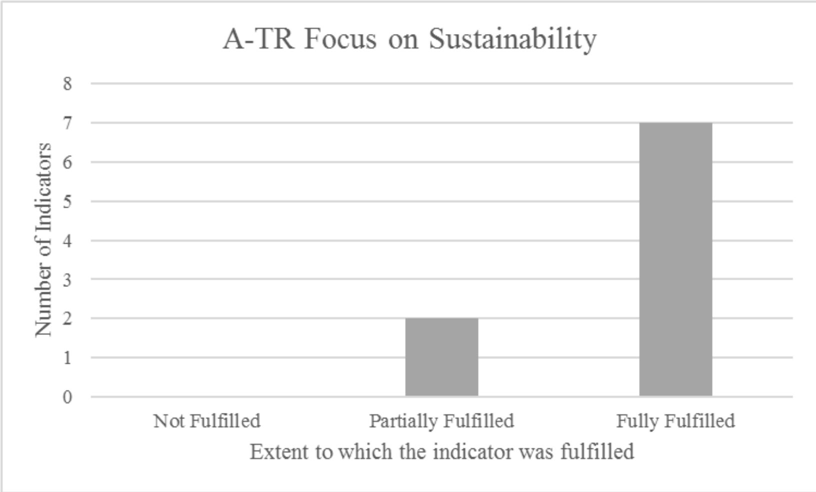

Figure 35. Focus on sustainability in A-TR

The practices of the A-TR preschool were in substantial agreement with the theories and concepts of sustainability[17]. The social, ecological and economic mainstream approach is frequently criticized in this context. Questioning gender roles in fairy tales and creating alternative approaches for these roles, organizing a swap festival, preparing cloth bags with children as an alternative to plastic bags, the campaign launched in the neighborhood to reduce the use of plastic bags, the construction of animal shelters as a parent involvement activity that will help the animals in the neighborhood to be sheltered in winter, the approach to diversity, children's involvement in agricultural activities, sharing leftovers with animals, and utilizing organic wastes in the compost bin are evidence that reveals the stance of the preschool on sustainability. This evidence was observed in the different dimensions of the preschool. This is explained in the following text on the preschool website:

> We are seeking new fairy tales in which Snow White is bored in the palace and turns into a good cotton manufacturer, Cinderella can dance with her boyfriend even though it is after midnight, or even walks with bare feet, The Pied Piper of Hamelin creates a beautiful orchestra with the mice and returns the children to the village, The Little Match girl starts and ends the day with a laugh, the ant can stop working for a time and play a *bağlama* or a guitar for a while, the cicada can develop a great interest in ecology using digging tools, the super heroes who save the world are not always men, the dragons are bored with kidnapping the princess and resign from this job, the kings and the queens are poorer than the villagers but live happily, and the big fish does not eat the small fish and no fights happen. So, our preschool was established in 2009 to create a place where this new fairy tale can be

[17] It should be noted that sustainability topics generally handled in the workshop entitled as the ecology workshop.

imagined. The Little Black Fish of Behrengi has been the inspiration to this school and a new fairy tale[18].

As stated above, the A-R preschool was created to be an alternative to mainstream education and the school is trying to ensure that the school staff adopt this approach through the process of in-service training. From the interviews, it was concluded that the competencies of the adults in the fields of ESD, EE and EfS were developed through intensive in-service training organized in the preschool. For example, a capacity-building study with a representative of an LGBT[19] organization was invited to talk to the teachers to discuss issues of sexual identity development, gender roles, and sexual orientation. Conducting in-service training to deepen teachers' knowledge of ecology is also planned as future activity.

The preschool's purchasing policy is neither fully sustainable nor completely unsustainable. When making purchases for supplies, equipment, and food for the preschool, there is a preference for fair trade and organic products, but product diversification is limited in Turkey in this sense, so the goal of becoming fully sustainable cannot be achieved. However, the staff of the preschool try to manage resources carefully by reducing, reusing, and recycling. Using reused and recycled material from nature and daily life is common in the preschool, both indoor and outdoor, as shown in Figure 36, 37 and 38.

Figure 36. Construction materials made by the A-TR preschool staff

[18] The story of Little Black Fish, is the unforgettable work of the Iranian writer Samed Behrengi.

[19] LGBT stands for lesbian, gay, bisexual, and transgender society in Turkey.

Figure 37. The garden of the A-TR preschool full of recycled materials

Figure 38. Retirement days of an old bathtub in the preschool

The quality of waste management in Turkey is very different from Germany; therefore, waste management in preschools is relatively poor in Turkey[20]. However, in A-TR, glass is recycled and organic waste is composted in the preschool and all materials are used very efficiently and carefully.

[20] For more information following website can be visited: http://ec.europa.eu/eurostat/documents/2995521/5160410/8-04032013-BP-EN.PDF/c8bcd2cd-a8d0-4bf1-b862-62209408c532?version=1.0

Diversity, although considered in a limited way [21], is one of the important components of this preschool: “A-TR preschool advocates that every child has different learning thresholds and motivations, and believes every child should be happy with his or her own identity” (Website of the Preschool). From this perspective, the staff of the preschool show they have full acceptance of people and their differences. The most senior administrator in terms of professional experience defined diversity as follows: “every color, every method, and every point of view in addition to those accepted as norm” (Administrator 2, A-TR). Hence, it was concluded that in the A-TR preschool there was a comprehensive approach to diversity and adults provided the definition of this term in a multi-dimensional way.

The cultural backgrounds and socio-economic status of the people in the school are similar to each other, so there is no substantial opportunity to appreciate a rich cultural diversity in this sense. However, cultural diversity is one of the topics on the agenda of the school. Children from different nationalities are painted on the facade of the school. There is a nursery rhyme that the educator team created by adapting the rhyme and rewriting the words. One of the focuses in the song below is cultural diversity (Table 34).

---

[21] The conclusion that the diversity component is handled in a limited way was reached for the following reasons: The number of individuals from different backgrounds was limited in the preschool. There was only one child who received a scholarship for attendance. This child was a member of a family living on minimum wage. Apart from this, there were no individuals belonging to disadvantageous groups in terms of income, ethnicity, religion, special needs, and sexual orientation. This led to the belief that the diversity component in this context was experienced in a limited way.

Table 34. Lyrics of a child song

Original Lyrics of the Children's Song	Adapted Lyrics of the Children's Song[22]
Let's make a snowman Put a carrot on his nose He is cold in this weather Let's wrap a neck scarf around his neck	Let's make Fadime out of snow Let's give a rake in her hand Let her work in the fields, grow vegetables and fruits
Let's make a snowman Put coal for his eyes He is cold in this weather, dress him up in a hat	Let's make Rojbin out of snow Let's give her a guitar She plays the guitar for the birds, let's sing together
The snowman is laughing Our teacher is coming We're done now We made our garden very beautiful	Let's make Sargis out of snow buys apples from the bazaar Carry them with his net bag instead of plastic bags
	Let's make Atra out of snow She loves to share Everybody come here when it is a swap festival
	Let's make a witch of snow Give her a broom She flies with the broom, makes playgrounds everywhere

It was observed that songs in different languages from different countries were played on the CD player when lunch was served to the children. The staff of the preschool provided the children the opportunity to learn to appreciate and compare natural diversity. In the ecology workshop, which is established only to learn, appreciate and compare diversity in nature, children undertake different activities every day.

4.3.3.3 Systems Thinking Skills of the A-TR Case Children

In this part of the case study narrative, there is a specific focus on the evidence found in the educational context that can be related to the Systems Thinking Developmental Rubric for K-Level. In this regard, the children's level distributions in each aspect of the case are presented in Figure 39.

[22] In this song, the names of both girls and boys are used instead of the snowman. Also, Rojbin and Sargis are names belonging to different ethnic cultural groups defined as a minority in Turkey.

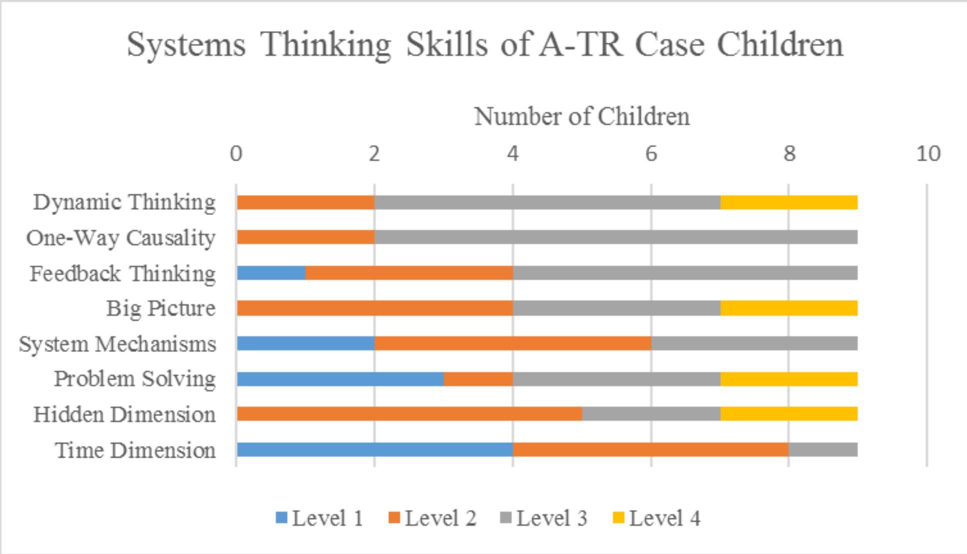

Figure 39. Systems thinking skill levels of children from the A-TR case

In this part of the study, 17 indicators are evaluated. A-TR did not fulfill nine of these indicators, partially fulfilled three, and fully fulfilled five (Figure 40).

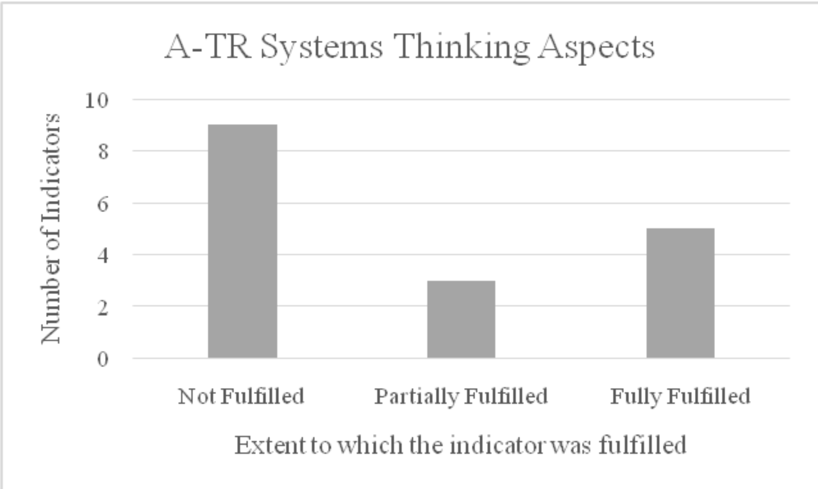

Figure 40. Systems thinking aspects in A-TR

4.3.3.3.1 Dynamic Thinking

In this aspect of systems thinking, the aim was to detect the children's dynamic thinking ability concerning whether they could understand changes in the components and processes that construct obvious and hidden patterns in the system. There are some previous practices in this preschool which supported the children in solving the pattern in the book that was discussed in this study and allowed them to comment on the gradual change in the amount of water. Statements from the adults refer to very frequent pattern practices with the children:

> We celebrate the birthdays of the children who were born in that month on a monthly basis. The children make cakes. Cake decorating is a great opportunity for us especially for pattern practice, for example, when decorating the cake, we create a pattern with two kiwis, two bananas, one strawberry (Administrator 1, A-TR).

The indicator referring to ‘there are educational materials concerning the use of mathematical reasoning exercises such as numeration, pattern building and discrimination of size’ was fully fulfilled in this case. In the Science Workshop the children have access to Montessori size and numeration materials, such as Numerical Rod, Pink Tower, Brown Stairs, and Cylinder Blocks, which are thought to be able to contribute to mathematical reasoning in the context of developing quantitative understanding (Figure 41 and 42). In addition to these ready-made materials, the teacher of this workshop uses different natural or recycled material to support the children in discrimination of size, numeration, and pattern studies (Figure 43). So, it was concluded that children practiced mathematical reasoning experiences such as numeration, pattern building and discrimination of size.

Figure 41. Montessori materials available in the science workshop

Figure 42. Other Montessori materials

Figure 43. Math materials created by the teacher

As shown in Figure 39, the children from A-TR performed mostly at Level 3 in dynamic thinking. A child who is performing at Level 2 is one of the children with the lowest total score in both this group and all cases[23]. Two of five children who performed at Level 4 belong to A-TR case. This was shown in their responses to the story about the water hole; one child was able to explain, "... the water in the water hole comes from the sea ... some of it goes back to the sea ..." (Sura, A-TR). The other child, established a circular behavior pattern over hidden components related to the effects of water depletion revealed in this dialogue:

> Investigator: Well, I think there are some things that are not given in this story. Think about them, too, will you? For example, you said the animals are gone because there is no water left. What else could be affected by water depletion?
> Derin: People would die if they were there.
> Investigator: Anything else?
> Derin: The ships would be stuck at sea.
> Investigator: Hmm, yes. What else?
> Derin: We cannot make concrete without water. So, we cannot find bricks.
> Investigator: Bricks? Are they made with water?
> Derin: Yes, and also ceramics.
> Investigator: Ceramics are made with water, so we cannot do that, either.
> Derin: And food cannot grow.
> Investigator: Then who is influenced by this or what is affected by the inability of food to grow?
> Derin: People again ... and we cannot fish (Derin, A-TR).

4.3.3.3.2 One-Way Causality

In this aspect of systems thinking, the aim was to assess the connections that children made in the story considering whether they detected the domino causality and multiple causality, as well as the direct and indirect connections. The children from A-TR case generally performed at Level 3. Three children performed at Level 4, and they described an extended linear pattern that includes a multi-step linear connection of three or more steps with indirect effects:

> Investigator: Well, who or what else can be affected by water depletion other than animals?
> Simya: Us.
> Investigator: How are we affected?
> Simya: We need it, we cannot wash our hands if there is no water.
> Investigator: Anything else?
> Simya: We cannot bathe.
> Investigator: Anything else?
> Simya: We cannot wash our face. We cannot drink water.
> Investigator: Who or what else could be affected?
> Simya: Hmm ... ... the soil may be affected.
> Investigator: How?
> Simya: Then, the soil would be dry and cracked.
> Investigator: Then what happens?
> Simya: Then the flowers cannot grow.
> Investigator: Mmm.

[23] The child aforementioned is the only scholarship student at the preschool. He comes from the segment with the lowest level of education and income.

> Simya: Because flowers are fed by water (Simya, A-TR).

During the period of observation in the A-TR case, there were two supervised activities that can be associated with one-way causality dimension. The first is the crying child activity described above, in which the questions have en element that is closely related to the one-way causality: Why is the child in the picture crying? What may be standing against this child? Why? What can we say to this child to calm her and make her stop crying? Why?

The other evidence of one-way causality occurred during the tent activity[24]:

> When the tent event was being held, one of the children showed the stakes and asked what these pieces were and why they were not used. The adult who was running the workshop told the child that the pieces were stakes and were used to fix the tents to the ground, and then added: “It's unlikely that we can fix the tent here, what is the floor made of ?” The children gave the response, “it's wooden” (Field Notes, Research Partner).

In conclusion, it can be stated that children were engaged in one-way causality experiences and the indicator referring to this skill was fully fulfilled.

4.3.3.3.3 Feedback Thinking

As mentioned above, the children have a strong linear causality background. In the feedback thinking aspect of systems thinking, the aim was to measure the children’s ability to detect the behaviors in the system that can “feedback” on each other to form positive and negative processes. Given the feedback loop in the story, evidence that will correspond to the statement patterns like ‘the more, the more’, ‘the less, the less’, ‘the more, the less’, and ‘the less, the more’ was searched for in the field work, but no such evidence was clearly found. Accordingly it was concluded that children were not engaged in closed-loop thinking practices. Three children closed the loop by not specifying quantities, and five specified the quantity while closing the loop. The children who specified quantity are those who used the statement patterns mentioned above. The child whose performance was evaluated at Level 1 (open loop) was the scholarship student.

---

[24] An adult who voluntarily contributed to the school came to the school with tents to be erected. The children and this adult erected these tents together in the garden of the school. In this process, the children erected their tent together after sharing their ideas on where and how the tents could be set up. Although the adult made some explanations to show how some parts were made, the tents were mostly set up by the children according to the instructions given by the adult (Field Notes, Investigator).

4.3.3.3.4 Big Picture Thinking

This aspect focused on measuring the children's ability to demonstrate a multi-perspective approach and comprehend a given issue from a more holistic perspective by asking questions, such as ‘What was this story about?’ and ‘What can be the title of the book’. In the interviews and observations, it was concluded that in the book reading activities, the children were frequently asked these kinds of questions and it was found that the preschool had about 200 children's books. The approach to the reading activity was observed as:

> When the book reading activity is being carried out, first, the book's author is introduced to children, then they are asked if they have previously read other books from the author, and they are encouraged to give their ideas on what the book might be about by looking the cover (Field Notes, Research Partner).

In this aspect, two of the five children corresponding to Level 4 belong to this case and they provided two multi-dimensional responses to both questions and displayed a relatively more holistic approach to the issues belong to this case. According to Simya, the book is about the water of animals, and the name of the book could be “animals and rains”. According to Göksu, the story is about the forest and the name of the story could be “water is finished”. In the A-TR case, three children were at Level 3, and four children performed at Level 2. One of the low-performing children was Bayram:

> Investigator: What was the story about?
> Bayram: Animals are funny in the story and do angry things.
> Investigator: Let's give this book a name, what can be the name of the book?
> Bayram: I do not know.
> Investigator: Let's think, we need to write a name on the cover of this book, what should we write?
> Bayram: Leopard.

4.3.3.3.5 Understanding System Mechanisms

For this aspect, the aim was to determine the children's understanding of system mechanisms by adding a new component to the system. Two children stated that there would be no change in the system and were categorized as at Level 1. Four children described only the potential local and short-term impacts of the addition of adding the new component to the system. Three children described the wider and long-term potential impacts of adding the new component to the system. There was no child who considered the possibility of unexpected changes in the system. Tools that can help to give high-level answers to this type of question include exercises, such as talking about a system in detail or asking ‘what happens if we remove this component or add this component’ when undertaking causality practice. No such tools were in evidence in the A-TR case.

4.3.3.3.6 Problem-Solving

The children's problem-solving ability in a given problematic system behavior was determined in this aspect of systems thinking. In the context of problem-solving, there is a conclusion that children have partially rich experiences in this educational context. This is supported by examples, such as the debate about where and how to set up the tent, the discussion on the crying child's activity concerning what can be said to calm her and make her stop crying? Another example of the rich experiences in A-TR is detailed below:

> Seeing the torn pages of a book in the hands of a child, the teacher asked, “Where do we take the books with torn sheets?” The children answered, “to the book hospital”. Everyone gathered in front of the book which was put into the book hospital after the planned activity was completed. The teacher asked them how they could repair this page. Some of the children said, “We can stick a tape here and there”, with their fingers pointing up and down, and someone said they could stick it from side to side. When they started sticking together, the teacher asked, “How could we repair this page if we did not have tape in the school?” Children had many ideas; sew it, use glue, stick it to the photocopy of the page (Field Notes, Research Partner).

In comparison with the A-GR case, it was concluded that children were partially let to encounter real-life problems and adults partially provided opportunities for children to solve problems on their own. In the framework of the problem-solving question the children were asked, three of the children's answers were evaluated in Level 1, one in Level 2, three in Level 3, and two in Level 4. One of the answers rated in Level 4 was related to delay awareness:

> Investigator: What would you do to solve this problem?
> Göksu: I will run fast to go quickly (here, the child expresses an early action before the water finishes).

Interestingly, there was only one response from this case suggesting a fair distribution of resources as a solution to the problem (Level 4). However, solidarity and sharing are among the themes which are frequently undertaken in the preschool. The swap song, which was composed and written within the preschool, was one of the songs that was often sung together, and the lyrics are as follows:

Let's set up a bazaar, and put love in the booth
Let's set up a bazaar, and let's put friendship in the booth
Make the things belong to me yours, let's swap them
Make the ones belong to you mine, let's swap!

In the context of Level 3, two children provided responses in the scope of preserving the commons by reducing the consumption, and one child has provided an answer that can be evaluated as expanding the carrying capacity categorization. Two children answered, “I would do the same, drink water”. Three children left this question unanswered.

4.3.3.3.7 Hidden Dimension

This dimension had the aim of assessing the children's ability to detect obvious and hidden components and processes in the system. In this aspect, it was deduced that children generally responded at Level 2 but two children gave answers at Level 4. According to Sura (A-TR), the water pictured in the book comes from the sea, some of it is drunk by the animals, and the rest goes to the sea again through the pipes under the soil. According to Derin (A-TR), water is decreasing both due to the animals drinking it and because of a mechanism like a magnet in the bottom of the water, which draws water into the soil. Since this aspect is related to the root-causes thinking skill and subject matter knowledge, there are two issues to be considered. One of the possible areas of supporting the hidden component is to talk about root causes. Conversations that are deep enough to focus on root causes when constructing cause and effect associations are not found in this case; however, imagination is a phenomenon supported in this case (see “How to repair this book if there is no tape” in the book repair activity). As mentioned above, the children in this case can act in semi-autonomous way, and adult supervision and child autonomy are found to be balanced in practice. The second issue related to this aspect is subject-matter knowledge. In this learning environment, there was no emphasis on subject-matter knowledge. Teachers delivered a few explanations related to different subjects, however those explanations could not be considered as opportunities to enhance subject-matter knowledge. Children's having some prior knowledge of the water cycle is a factor which makes it easy to comment on hidden components and processes. Deducing from the conversations with the teachers, it was concluded that the children had not had any previous educational experience of discussing the water cycle, population, and animal migration in the A-TR case.

4.3.3.3.8 Time Dimension

For the last dimension in systems thinking, the aim was to detect the children's ability to comprehend time and make a future prediction. In order to collect data in this area, an assessment was made as to whether the future prediction work was undertaken with the children in the field and if there were conversations about the past-present-future connection and about time in general. No clear evidence concerning time in general and future prediction in particular was obtained from the A-TR case. The conversations about past-resent-future connection only included patterns for past-present connection, as indicated in the sentence, “we have already read another book by the same author”. Four of the children's future prediction skills were at Level 1 and four children at Level 2. Another child corresponding to Level 3 only made a future prediction on an existing pattern. According to this child, the animals will finish water, they will go to another place, it will rain, water will re-accumulate, it will be consumed again, the animals will go to another place, and they will return to the waterhole but this time and the animals will find the well empty because the rain is not sufficient and they will move on again and not return.

4.3.4 The Alternative Education Case from Germany (The A-GR Case)

4.3.4.1 Description of Educational Context at Meso Level: The A-GR Preschool

4.3.4.1.1 General Information about the A-GR Preschool

The A-GR preschool is located in the Karlshorst district, in the east of Berlin. This preschool provides services under the non-public non-profit preschool status, and there are places available for children whose families are in financial difficulties. Since 2013, the A-GR preschool has been providing ECE services for up to 70 children of families with different social and economic backgrounds. The age of the children attending the preschool varies in a vast range, from eight weeks to seven years old. The preschool was established to provide ECE services primarily to children of students attending a particular university or the teaching staff of the institution. If there are also available places, then the children of the families where preschool is located can also be enrolled.

The A-GR preschool occupies a physical area composed of approximately 800 m² of indoor space and about a 600 m² open area. The closed area is structured with two wings with the administration office in the center. One of the wings was arranged for the use of children in the 0 and 3 age group. The other wing has been designed as a big space for the three- to six-year-old children. Observations made within the scope of the research were conducted in the wing used by the older age group. In this section, the construction play room, dreamland, puppet paradise, art workshop, yoga room, and dining hall are located. Meals are prepared by a catering company and delivered daily to the preschool. During the observation period, no emphasis was found on organic nutrition. The garden of the preschool is quite large and contains rich play facilities. In this garden, apart from a large playground containing a slide, swing and climbing area, there are wide tracks where children can ride variety of bicycles and scooters, also plenty of trees and bumpy green spaces. The definition of the ECE provided by the A-GR preschool is as follows:

> We offer the children diverse and age-appropriate experiences by challenging them to take action by themselves so that early childhood education we provide can be successful. In that sense, the role of the teachers in our center is to supervise the children in their learning processes by showing them ways to expand their skills (Web site of the institution).

4.3.4.1.2 Pedagogical Approach of the A-GR Preschool

The A-GR preschool conducts pedagogical processes with an open concept (*Offenes Konzept*) approach. This concept was born from the critiques of traditional education (Mienert & Vorholz, 2013). According to this approach, traditional educational contexts provide the children with overly structured experiences, and this needs to be reconstructed in a revolutionary way[25]. Within this concept, the physical space of the A-GR preschool has been divided into rooms which are structured with specific concepts. Apart from a few structured activities, children construct their own experiences by spending time with their mixed-age peers in the indoor and outdoor places of their choosing. During the observation process, the following structured activities are conducted: morning circle attended by approximately 35 children each morning, yoga practice once a week, a weekly sports activity, and some sessions with the preschool puppet. With the exception of the above-mentioned activities, the children were engaged in free play until lunch time in their wing and outside with the peers they chose.

In the website of A-GR, it is stated that the preschool focuses on ESD and natural scientific experience as the powerful components of the concept they apply. However, after the observation period, it was concluded that both the administration and the teaching staff had little prior knowledge and practice in this regard. In the interview with the most senior teacher, she stated that they only recently started to separate the garbage and did not know what to do in the field of ESD: "Indeed, there is not much I can say about this. I don't have any idea about this issue; we have to come together to talk about it. For now, we only separate the waste items" (Teacher, A-GR).

The basic principles of the ECE service offered at the preschool are as follows:

- We nurture and support the children in the individual development of their personalities.
- We encourage the children to form their own opinions, on which they can base their own decisions.
- We teach the children creative skills which promote their sense of responsibility.
- We raise the children's awareness of responsible approaches to natural resources.

[25] Almost in all German preschools, forming a core group is essential. Only 5% of the preschools work with open groups without forming core groups (Linberg, Baeumer & Rossbach, 2013).

- We promote the development of social and emotional skills, so that the children develop a sensitivity to their own needs and the needs of other people.
- In an age-appropriate way, we develop the children’s understanding of democracy.
- We make it possible for the children to have varied, holistic experiences.
- We give the children time to play so they can process their experiences.
- We encourage the children to use exploration and experiment to discover their own solution-finding approaches and develop problem-solving thinking.
- We value a good, trusting educational partnership with the parents.

As can be understood from the principles above, the basic philosophy of the school is structured around children taking initiatives, standing on their own feet, satisfying their own needs, taking responsibility for themselves, and playing. Although it was stated that in the school, the education processes are carried out with group understanding, this was not been seen in the observation period. During yoga practice and sleeping hours, a group mentality was in operation according to certain age groups, and in all other processes, the children were usually left alone under the supervision of two adults, or joint gatherings of all the children were organized. As with many preschools in Germany, the children went on many regular field trips, visiting theaters, exhibitions, playgrounds, and museums near the preschool. However, no such kind of excursion was arranged during the observation period.

The A-GR preschool operates under one of the vocational colleges located in Berlin. This college provides training for candidate physical education teachers, and they are required to plan and implement physical activities for young children as part of a pedagogically focused lesson they attend. Once a week, the children in the A-GR preschool are taken to the sports hall of this vocational school which is only a short walk away. Teacher candidates implement educational physical activities they have planned with the children from the preschool. During the observation period, some of the children went to the sports hall and engaged in the planned physical activities.

One of preschool’s principles of practice is teaching the rules of the preschool. This can be seen in the institution's website and also was explained by a teacher in an interview: “These children will go to primary school after a while, and they will encounter many rules there. There are rules here too. We now predominantly underline this, it is very important for us to make children learn rules, to get on with each other, and agree to the daily flow" (Teacher, A-GR).

4.3.4.1.3 Characteristics of the A-TR Preschool Staff

This preschool has an administrative team of two people, one administrator and one assistant administrator. The assistant administrator also taught the 0-3 age group at certain times. Three people in the teaching staff were senior educators (they had 15+ years of professional experience). The preschool administrator and the remaining three teaching staff including the assistant administrator had teaching experience ranging from five to 10 years. There was also an intern. During the whole week of the observation, preschool administrator was not at work due to illness. Five teachers, one intern and one housekeeping staff were assigned to the three-six-year-old group in this preschool. During the observation period, two teachers were on sick leave, three teachers and an intern were left to meet the needs of 38 children. In fact, since the other teacher had to undertake some tasks in the absence of the administrator, including organizing the lunch, there were only two teachers who were responsible for 38 children who were spread all over the internal and external areas of the preschool.

4.3.4.2 Description of the Case

This part of the thesis presents the characteristics of the participants and the contextual description of the A-GR case within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.4.2.1 Profile of Child and Adult Participants

As shown in Table 35 and Figure 44, three girls and five boys from this preschool participated in the study, and half of them were bilingual. Regarding the parents' education level, at least one parent of the children had a minimum undergraduate level of education. The mean ECE enrollment age of nine children was 21 months.

Table 35. Profile of child participants from the A-GR Case

	Characteristic	Frequency	Percentage
Gender	Girls	3	37.5%
	Boys	5	62.5%
Age	48-59 months old	5	62.5%
	60-71 months old	2	25%
	72+ months old	1	12.5%
Bilingual	Yes	4	50%
	No	4	50%
Education Level of One of the Parents	University degree or above	8	100%
	Less than university degree	0	0%
Mean ECE Enrolment Age: 21 months old			
Mean Age: 58 months old			

N=8

The mean age of the child participants from the A-GR case was 58 months. The gender and age distribution of the children are given in Figure 44.

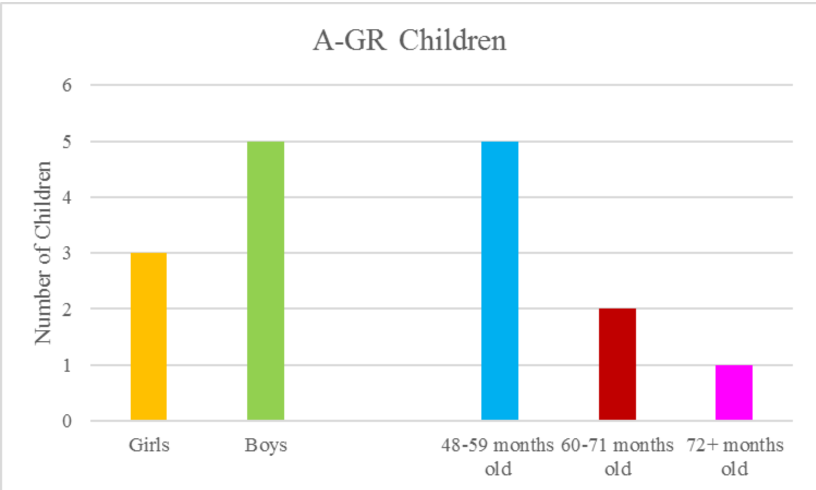

Figure 44. Gender and age distribution of children from A-GR Case

Two adults from the A-GR preschool participated in the study; the administrator and the most senior teacher of the preschool, who were both female. The teacher had vocational high school degree and the administrator had university degree in ECE. The administrator had eight years of experience. The senior teacher had 40 years of professional experience. Both participants had been providing ECE services since the preschool was established. The average age of the participants at the time of the study was 55.5.

Next part of the thesis presents the contextual description of the A-GR case within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.4.2.2 Preschool Climate

In the first part of the checklist, in the section on preschool climate, the preschool's internal dynamics and the level of communication with the outside world are given. A-GR fulfilled three of the six indicators fully and two partially (Figure 45). One of the indicators was not fulfilled.

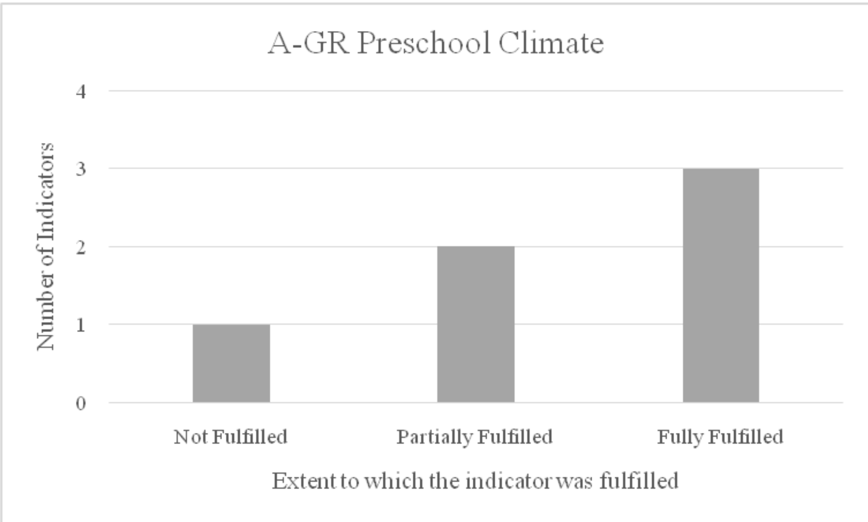

Figure 45. Preschool climate in A-GR

In this preschool, opportunities for teachers and parents to have a say and be involved in all issues and themes that affect them are supported by institutionalized participation structures. The administrator of the preschool stated that the teachers who were assigned to older age groups have monthly meetings (referred to as branch meetings). Additionally, all the teachers and the preschool administration team meet four times in a year to discuss the issues in preschool from a common agenda they have agreed upon. Thus, staff feedback and consultation sessions take place regularly in this preschool. In the three- to six-year old learning group, the parents democratically select four spokespeople (*Elternvertreter*) to maintain communication with the families in their group, act as a participatory body, and when necessary represent the entire group in important issues with the group teacher and preschool admin. These parent spokespeople meet with preschool administrators twice a year. The above-mentioned participatory mechanisms between teaching staff, administration staff, and parent are clear evidence of the adults acting out democratic forms of conflict resolution in the preschool. All these mechanisms create grounds for solving possible conflicts in the process of formation. In the A-GR preschool, there was no evidence of a structural approach to conflict situations among the adults in the M-GR preschool. Both the interviewed teacher and the administrator stated that team members try to resolve their issues among each other, when this does not work then they bring up the issue to the branch or the general meeting to involve the other team members in the conflict resolution processes. Accordingly, it was concluded that adults partially act out democratic forms of conflict resolution. There was no structural approach in the preschool in terms of fostering the negotiation and conflict resolution processes of children. The investigator and her research partner did not find evidence that shows the children have some kind of conflict prevention work among themselves together with their teachers as it was found in the M-GR preschool. Hence, it was concluded that there was not a structural approach to conflict resolution among children.

In the A-GR preschool, there was a limited approach to staff development and learning, especially when compared with the M-GR preschool. The administrator of the preschool stated that at the beginning of each year, they have a detailed discussion with the teaching staff about their in-service preferences. Accordingly, they try to allocate financial resources and time to support the preferences of teachers. However, all the expectations of the teachers are mostly not met due to school not having sufficient financial resources and team members to provide cover for a teacher attending in-service training.

The preschool works in close cooperation with individuals, organizations, and authorities outside the preschool in order to open up external spaces for experience and learning. The administrator of the preschool explained that she meets once a month with the administrators of other preschools in their region, and exchange ideas for further development of their school; additionally, opportunities for cooperation is created. The administrator explained that they organized a charity event in which the children and their parents of preschools in the region were actively involved in raising funds to buy gifts for 500 refugee children. Also, similar to the M-GR preschool, the A-GR preschool cooperates with the elementary school in their region and children were taken to this learning environment from time to time. Additionally, this preschool uses facilities of the vocational college which is located nearby.

Next part of the thesis presents the contextual description of the A-GR case within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.4.2.3 Physical Space

Four of the nine indicators discussed under this heading were fully fulfilled and one was partially covered. Two of the indicators were not fulfilled (Figure 46).

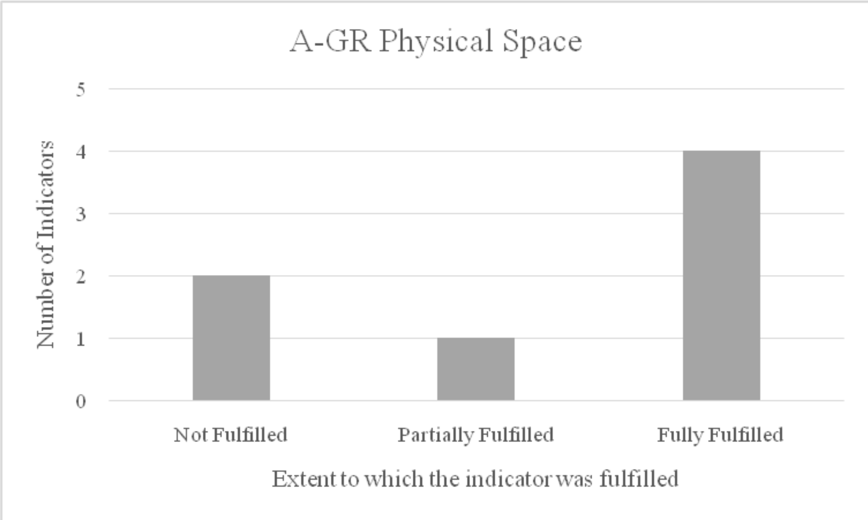

Figure 46. Physical Space in A-GR

As previously reported, children in the three to six age group at the A-GR preschool use the outside and indoor areas of one wing of the preschool. Due to the "open concept" which is a pedagogical approach that was utilized in the preschool, children were able to play freely in and out of all the rooms whose doors were open. In the field notes, it was noted that except for the morning circle, yoga time, lunch time, and sports time, almost all the children chose to play in the school garden, even though the weather was cold[26]. Therefore, it has been concluded that children belonging to the A-GR case had access to all parts of outdoor and indoor space with the most comprehensive opportunities when compared with all the cases. The children also had open access to most of the materials. The indicator 'there is a rich and abundant amount of materials that children can use in many ways' was partially fulfilled in this preschool. The preschool administrator noted that they continued the process of buying toys and supplies, but they knew at some point they would fall short

[26] During this time, one teacher stayed indoors and monitored the children playing inside. Two adults took turns to supervise the children playing outside.

in terms of materials. However, it should be noted again that the indoor environment was designed in a highly suitable way and the possibilities in the art workshop were exceptional (Figure 47).

Figure 47. Picture from the art workshop

It was noticed that the number of books accessible to the children was limited in this preschool. When asked about this situation, it was understood that the teachers continued to purchase books. In response to the question concerning which books were used at book reading time, it was reported that some of the books were in a cupboard. Two of the book reading sessions were observed. During this period, a chapter of the novel Matida by Astrid Lindgren, the famed Swedish author of the Pippi Longstocking series, was read every day. The book is about seven-year-old Matida, who is considered as a difficult child. She has crazy ideas like jumping with umbrellas from the roof and has a difficult temperament. In the book reading sessions, the teacher read the chapter but did not interact with the children.

The children were given the time and space to use the materials. A significant portion of the materials was positioned for easy access by the children. There was no clear emphasis on systems in the learning environment, hence the children were not able to see and touch the systems.

4.3.4.2.4 Approach to Learning and Experiences

There are six indicators discussed in this part of the report. The A-GR case did not fulfill four of these indicators, partially fulfilled one, and fully fulfilled one (Figure 48).

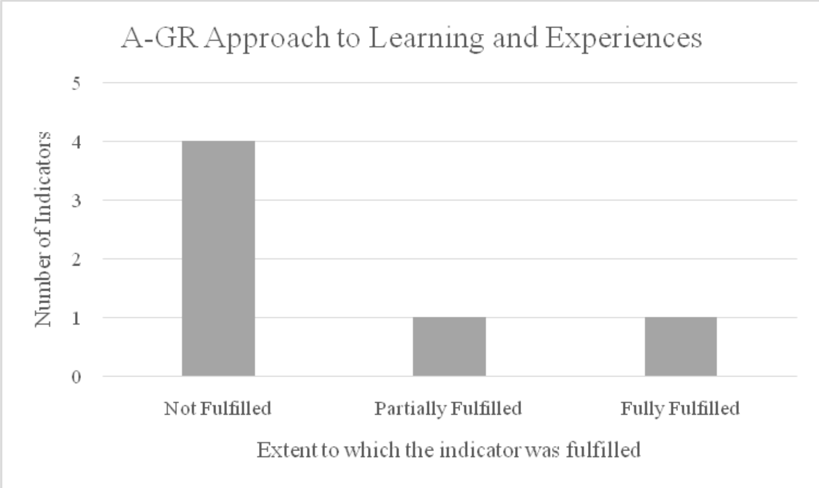

Figure 48. Approach to learning and experiences in A-GR

As a result of the observations and the analysis of the monthly plans, it was concluded that there was no preplanned educational content in the A-GR preschool, and this was validated in the interviews. The most structured activities during the day were: chatting in the morning circle, singing, performing a short event, having lunch together[27], having a nap routine (the book reading session described above was performed immediately before sleeping) participating in a yoga exercise during yoga time, participating in a sports exercise at sports time, and undertaking some table activities (not exceeding 15-20 minutes per day for the older age group)[28]. Except these times, children were totally engaged in free play in the space they chose. Though it was reported that structured activities were performed in small groups or with some children individually during some periods to achieve some of the most basic curriculum goals in the *Berliner Bildungsprogramm*, these learning experiences were never witnessed during the observation period. In conclusion, in this learning environment, the learning experiences were not linked, and subject-spanning and project-based learning were not utilized. Following the detailed review of the elements mentioned in interviews, lesson plans and observed in the environment, it was concluded that the structured activities were designed in different disciplines, and most were

[27] In some open concept preschools in Germany, lunch is served as an open buffets. In this situation, the food is kept in the dining room for a certain period of time, during which the children take the food they want in the amounts they like and manage the lunch process themselves. There is no such thing as starting and ending the meal together. At the A-GR preschool, children and adults start lunch at the same time and eat together.

[28] These activities include activities, such as handcraft, letter and number work, and painting exercises, which were organized to prepare the children for primary school.

disconnected, one-shot, and surface-level activities. Although the learning experiences in A-GR were designed to be partially multi-disciplinary, no binding learning experiences were found to provide for an inter-disciplinary transition. In this sense, children's learning experiences were multi-disciplinary, yet not interdisciplinary.

Three types of documentation techniques were used in the A-GR preschool; the language learning diary (*Sprachlerntagesbuch*) detailed in the M-GR cases, which is an important part of Berlin ECE curriculum, the observation sheet created and used by teachers of the preschool, and the learning and development folder created for each child. This folder contained images and short descriptions with pictures from the child’s own work and that undertaken with peers and adults in the preschool. The file also contained examples of pictures the child had drawn, which were accompanied by the teacher’s explanation of what was depicted in the drawings. There were about 10 pages for each child in the file. A comparison of the learning and development folder prepared in the M-GR preschool and the contents of the folder from in the A-GR preschool revealed that the latter did not contain deep learning experiences. The main reason for this was the lack of educational content in the preschool. The language learning diary mentioned above and the observation sheet were suited to adult use. The learning and development documentation tool was open to children's access and use, and partially allowed the children to see their own learning processes throughout time.

4.3.4.2.5 Thinking and Acting Routines

There are 12 indicators under this heading. In A-GR, four of these indicators were fully fulfilled, three were partially fulfilled, and five were not fulfilled at all (Figure 49).

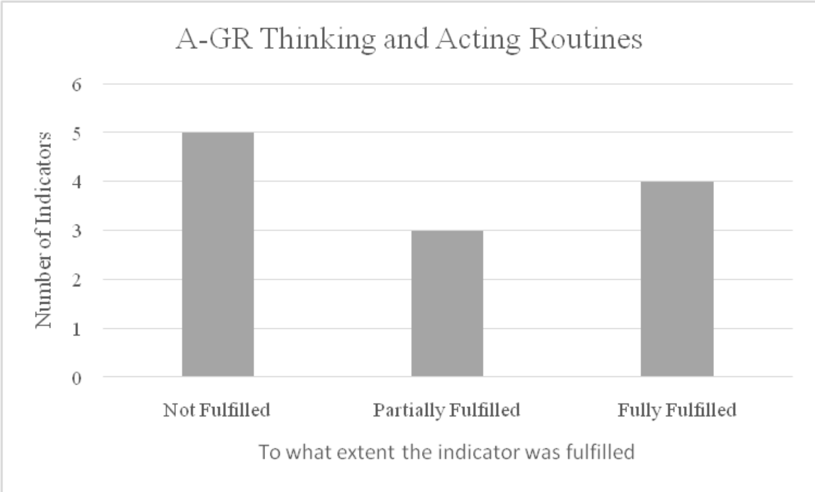

Figure 49. Thinking and acting routines in A-GR

A-GR was the case which had the lowest child-adult interaction. Teachers' contact with children was limited except for giving simple directions, answering some questions, and being involved in special situations[29]. The adults in the preschool did not ask cognitively challenging questions. The questions posed to the children were mostly of a matching perception type (Level I) and selective analysis/integration of perception type (Level II) questions. It was also not witnessed that a subject was discussed at length and in depth during the observation period although the children could talk freely with each other and were also allowed to ask questions. However, it has been concluded that these communication processes did not have an educational nature. The children's communication with each other and their level of learning from each other seemed to be higher than the interactions with the adults. It has been recorded in field notes that the older children helped the younger ones when playing games in the garden and explained how to use the gardening equipment.

The indicator referring to adults listening to and encouraging children's thinking in an engaged way was partially fulfilled. Yet, the adult-child ratio was not appropriate in this learning environment. Teachers were very busy in the daily flow. Furthermore, the adults created opportunities for a range of viewpoints indicator was not fulfilled in this case.

[29] There were two issues that can be assessed in the context of a special case. Two children in one room started a physical fight with each other, and the teacher interfered. In the other, one of the children's finger was trapped in the garden door. The teacher did the first aid to the child, then took her on her lap for a while. The child did not calm down for a long time, and her family was called in the end and the child was sent home.

Collective circles were held together with about 40 children but no discussion environment was created during this period. The indicator referring to adults focusing on individual children or creating small group for understanding was not fulfilled in this learning environment. As a result of the information gained in the interviews, it was understood that some preparation for the transition to primary school were undertaken with the children soon to start primary school. Wrap-up or reflection exercises at the end of the activities were not observed by the investigator and her partner; yet, no activity was applied in the educational context, so there was no ground for a wrap-up exercise like that. Adults partially displayed flexibility when creating learning opportunities. The morning circle was conducted by the most experienced teacher of preschool; however, when that teacher was attending in-service training after another teacher explained to the children why the teacher was not in school, he performed the following activity with the children that was not in the routine of the preschool:

> The teachers spread a cloth over one of the small tables in the art workshop and said, “This is a stage now,” and asked the children what a stage was. After hearing the answers, he explained, “We will take to the stage when we want to sing, dance or tell a story.” Then, he stepped on the table, greeted everybody, and said, “today I want to sing a French song”. He sang, and the kids applauded, bowed and greeted everybody. “Each of you will go on to the stage and make a short performance; you can joke, you can tell a story, you can sing, you can do a movement, but do not forget to say hello, and then tell us what you will do, and when your performance is over, greet us again and leave the stage”. The first child got on the stage and said, “I want to come off”. The teacher said, “OK,”. The children who wanted to perform got on the stage one by one, sang, made jokes, told stories, and the event ended when the children finished their performances (Field Notes, Research Partner).

Adults partially created open-ended experiences to foster creativity. The aforementioned performance activity and the Fasching celebration were the only creative activities that were seen during the observation period. An extract from the investigator’s notes describe the day of the Fasching celebration in the preschool.

> The children and the teachers came to preschool wearing costumes. A few songs were sung in the morning circle. The children were more active today than on other days. In the process of singing, the teacher had to make more effort than usual. After singing, the teacher sent the children to the dining room one by one, after which all the teachers joined children. French songs were being played in the background, and a small candy table was set up. The children and teachers of young age groups in the other wing of the preschool also joined the celebration. The children ran, danced, and joined the candy eating competition. Then, gradually the children, on their own initiative, went to play games in other rooms. Everyone was free to do what they wanted for a while. That day, the children were engaged in intensive role-play. Three children dressed in Native American Indian costumes came together and tried to make a Native American tent out of the cushions and covers in Dreamland. Then, the teachers announced that collective photograph would be taken, and the children were placed in appropriate places one by one, but two children did not want to take part. After all the other children were settled in position, these two children were invited again, but they still did not want to join, and others did not insist. The French teacher counted up to three in French and said, “Close your mouths.” Then, he explained, “If I have to shout, I would become very tired and sick, and I couldn’t make you pancakes.” After the photograph was

> taken, the children were sent to the dressing room to put on outdoor clothes and went out to the garden (Field Notes, Investigator).

The indicator referring to adults providing the children with the space to participate in decision-making processes in line with their age and abilities was not fulfilled, because during the observation period, no situation was experienced that required collective decision-making processes. Adult supervision in the A-GR preschool was at a minimum level, the indicator referring to the adults encourage children to do things for themselves was fully fulfilled in this learning environment. Children had to solve the problems they face in the daily flow on their own, and if they were unable to resolve them; then, adults helped them out. Free play was extensively encouraged by adults. The core of this educational context was free play and exploration.

4.3.4.2.6 Focus on Sustainability

There are nine indicators under this heading. In A-GR, three of these indicators were fully fulfilled, three were partially fulfilled, and three were not fulfilled at all (Figure 50).

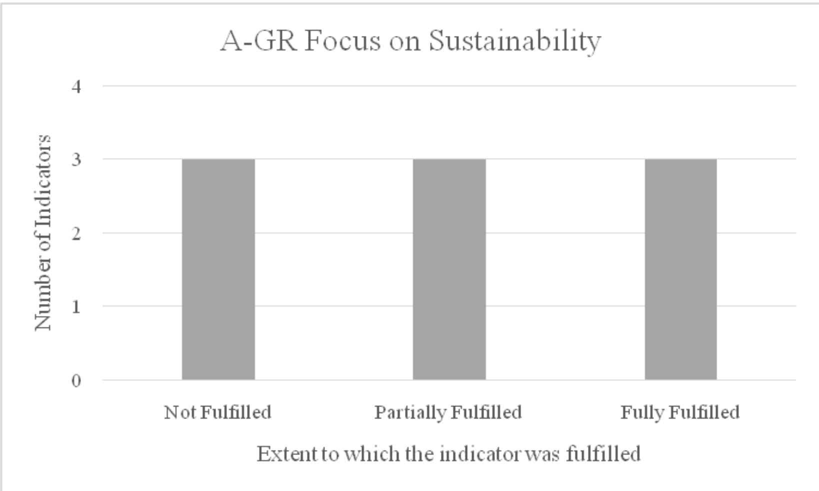

Figure 50. Focus on sustainability in A-GR

The practices of the A-GR preschool were not in agreement with the theories and concepts of sustainability. The topics concerning sustainability were not integrated into internal preschool teaching plans and curricula. This conclusion was made from the observations and examination of documents, and also from the interviews with the adult staff of the preschool. The extract below from a teacher and the administrator shows the lack of sustainability practices:

> To tell you the truth, we have not done anything in the ESD field yet. We also do not have

much infrastructure in this regard. One of the reasons we have accepted your research was to find out about some issues in the field of ESD. We have started to separate our garbage. We also give the leftover food to a man who has a small pig farm, and he gives the food to his pigs. He recently brought some sausages to thank us for our contribution (Teacher, A-GR).

Education for Sustainable Development has been imposed on us and the other six preschools that are affiliated with *Studentenwerk* organization by the organization, and we are trying to adopt this topic. As yet, we have made little steps (Administrator, A-GR).

It was clearly stated that none of the adults in the preschool received pre- and in-service trainings in the fields of ESD, EE and EfS.

The preschool's purchasing policy is neither fully sustainable nor completely unsustainable. When making purchases for supplies, and equipment for the preschool, there was a clear preference for buying durable and high quality materials. Although they were trying to pay attention to the selection of organic products when making food purchases, no clear criterion was mentioned as in the M-GR preschool. Using reused and recycled material from nature and daily life was not common in the preschool. In the context of this indicator, there was no evidence other than the reuse of newspapers in the art workshop. The indicator referring to the staff of the preschool try to manage resources carefully by reducing, reusing, and recycling was partially fulfilled. Like many preschools in Berlin, waste management is one of the things that was carefully managed, and activities performed in this context were the same as those undertaken in the M-GR preschool (Figure 51).

Figure 51. Pictures from the visit of the Müllmann (Garbageman)

The diversity concept was addressed in the context of culture in this preschool: “Diversity is one of the most important components of our preschool, children from different cultures meet in this space. We employ an 'all under one roof' approach to offer children the opportunity to get to know other cultures and languages” (Web site of the institution). The extract below demonstrates how the cultural diversity context was defined:

> When it comes to diversity, different countries, cultures, accepting everyone as they are and learn from everyone comes to mind. We always support the children in talking about these issues. We create opportunities for the children to talk about their own countries and traditions. In some festivals, we emphasize some countries, children bring food from their own culture, and they wear local costumes. Thus, children have an idea of different cultures, clothing and eating styles (Teacher, A-GR).

Activities performed in this context include counting and singing in the morning circle in English and French in addition to German, as well as counting activities in different languages before lunch time. In the context of emphasizing cultural diversity, a map (Figure 52) was a physical artifact that showed each child’s country of origin. This poster was considered as proof that preschool was able to provide a very rich experience for children in the context of cultural diversity.

Figure 52. Picture of the map shown the nationality of the children

It is important to note that there were two Syrian refugee children in this preschool. As understood by the evidence cited above, the staff of the school had a full acceptance of people and their differences.

This preschool’s outdoor opportunities were more varied than the other preschools, the school garden was set in a large area with rich botanic features. Thus, the outdoor area provided children opportunities to explore diversity in nature. However, during the observation period, an educational activity in the context of nature was not realized and neither did this issue feature on the agenda in the interviews. Thus, in the A-GR preschool, no educational structure in terms of children's relation to nature was observed, but the children were free to engage in the exploration of nature. Therefore, in this context, the indicator stating that adults provide children with the opportunity to learn, appreciate and compare diversity in nature was partially fulfilled.

4.3.4.3 Systems Thinking Skills of the A-GR Case Children

In this part of the case study narrative, there is a specific focus on the evidence found in the educational context that can be related to the Systems Thinking Developmental Rubric for K-Level. In this regard, the children's level distributions in each aspect of the case are presented in Figure 53.

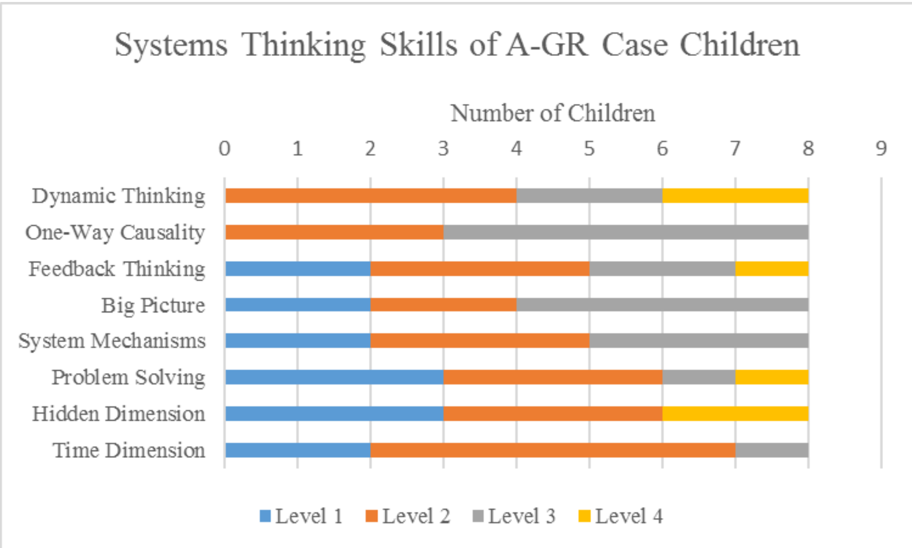

Figure 53. Systems thinking skill levels of children from A-GR case

In this part of the study, 17 indicators were evaluated. A-GR did not fulfill 11 of these indicators, partially fulfilled three, and fully fulfilled three (Figure 54).

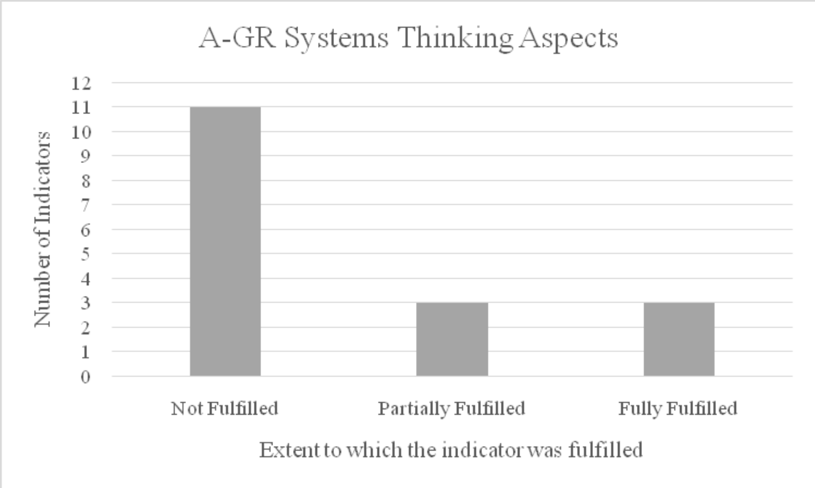

Figure 54. Systems thinking aspects in A-GR

4.3.4.3.1 Dynamic Thinking

In this aspect of systems thinking, the aim was to detect the children's dynamic thinking ability concerning whether they could understand changes in the components and processes that construct obvious and hidden patterns in the system. Educational materials concerning the use of mathematical reasoning exercises, such as numeration, pattern building, and discrimination of size were not encountered in this case. Consequently, it was concluded that children did not practice mathematical reasoning experiences, such as numeration, pattern building, and discrimination of size.

As shown in Figure 53, the children from the A-GR case performed at different levels: four children performed at Level 2, two children at Level 3 and two children at Level 4. One of these two boys, Ben Alex, was described in detail in the first part of the findings chapter with quotations from his interview. According to the other boy, Anselm, rain comes from the sky, then falls down, goes under the ground, then goes out again from the ground.

4.3.4.3.2 One-Way Causality

In this aspect of systems thinking, the aim was to assess the connections that children made in the story considering whether they detected the domino causality and multiple causality, as well as the direct and indirect connections. As shown in Figure 53, the children from the A-GR case performed at three different levels: five children performed at Level 2, and three children performed at Level 3. During the period of observation in the A-GR case, there was only one sentence uttered by one of the teachers that can be associated with one-way causality dimension: "Children, if I have to shout, I would become so tired and get sick, then I could not make you pancakes". In conclusion, it can be stated that children were not engaged in one-way causality experiences and the indicator referring to this skill was not fulfilled at all.

4.3.4.3.3 Feedback Thinking

As mentioned above, abilities of children regarding the dynamic thinking and one-way causality building differed from each other. In the feedback thinking aspect of systems thinking, the aim was to measure the children's ability to detect the behaviors in the system that can "feedback" on each other to form positive and negative processes. The indicator referring to the engagement of the children in closed-loop thinking practices were not fulfilled in this case. Given the feedback loop in the story, evidence that will correspond to the statement patterns like 'the more, the more', 'the less, the less', 'the more, the less', and 'the less, the more' was sought in the field work, but no such evidence was clearly found. Two children from this case did not engage in closed-loop thinking during the interviews and their performances were evaluated at Level 1. Three children closed the loop by not specifying quantities, and two specified the quantity while closing the loop. The children who specified quantity were those who used the statement patterns mentioned above. There was only one child who could recognize multiple-closed loops and performed at Level 4. This child's total score was the highest of all the participants[30].

4.3.4.3.4 Big Picture Thinking

This aspect focused on measuring the children's ability to demonstrate a multi-perspective approach and comprehend a given issue from a more holistic perspective by asking questions, such as 'What was this story about?' and 'What could the title of the book be?'. In the interviews and observations, it was concluded that in the book reading activities, the

---

[30] Ben Alex, who belongs to the A-GR case, has achieved the highest score of all children. In the observation process, both the investigator and research partner noticed this child, because he generally preferred to be farthest away from the other children in group work. He did not participate in group work. On the last day of the observation, a short conversation was held with the teacher about this child. It was understood that this child has German parents with a university degree but he was being raised by his a single mother. Although developmentally he was eligible to start an elementary school, with the common decision of his mother and his preschool staff, it was decided to send him to elementary school a year later because he was thought to be relatively behind in terms of social development. We also reported our opinion in this regard and explained how, among the 52 children that were interviewed, this child had a very high score in terms of the cognitive level. We considered that one of the reasons for the child's lack of participation might be due to the difference in cognitive level between the child and the other children in his age group. This situation revealed that children's developmental issues were not closely monitored in the A-GR preschool.

children were not asked these kinds of questions. As mentioned above, the book titled Matida was only read to the children and no questions were asked.

In this aspect, none of the children provided responses corresponding to Level 4, which means there was no child from this case who provided two multi-dimensional responses to both questions and displayed a relatively more holistic approach to the issues. In the A-GR case, two children performed at Level 1, two at Level 2, and four at Level 3. According to Alicia, the book is about the water of animals, and the name of the book could be “animals book”. According to Joan, the story is about the animals who drink the water, finish it up and then it rains and there is water again, and the name of the story could be “waterhole book”.

4.3.4.3.5 Understanding System Mechanisms

For this aspect, the aim was to determine the children's understanding of system mechanisms by adding a new component to the system. Two children stated that there would be no change in the system and were categorized to be at Level 1. Three children described only the potential local and short-term impacts of the addition of adding the new component to the system. Three children described the wider and long-term potential impacts of adding the new component to the system; for example, according to Alicia, if people were also included in the story, they would eat food and drink water, and there would be less food and water left for the animals. There was no child who considered the possibility of unexpected changes in the system. Tools that can help children to give high-level answers to this type of question include exercises, such as talking about a system in detail or asking ‘what happens if we remove this component or add this component’ when undertaking causality practice. No such tools were in evidence in the A-GR case.

4.3.4.3.6 Problem-Solving

The children’s problem-solving ability in a given problematic system behavior was determined in this aspect of systems thinking. In the context of problem-solving, it was concluded that children in this learning context had different opportunities when compared to other cases. Children were fully allowed to encounter real-life problems, and the adults provided opportunities for children to solve problems on their own. As previously reported, due to the A-GR preschool's pedagogical approach, children were left to discover their own solution-finding approaches with an unconventional method; that is to say, the elimination of adult guidance. Apart from allowing the children freedom in order to enhance this skill, another tool was also used, which was Cosa, the puppet of the preschool. The preschool administrator stated that they generally deal with the main problems observed in the whole group, and individual problems in some cases through Cosa. In this way, they could handle with some issues can be addressed without labeling individual children. In the observation process, using Cosa for this aim was not witnessed, but the following event was carried out with Cosa:

> The children were gathered in the puppet land room. There was a Tibetan bowl in the middle, a maul was handed to one of the children, the child made the bowl tinkle with this maul, and everyone stopped talking. Then the child got up and knocked on one of the closets. The teacher turned his back, changed his voice, and yelled, “who is that?” The child introduced himself. “Ah, is that you, wait a minute, I am coming” she said. Then, the teacher opened the door of the cupboard and took Cosa the puppet from inside. The teacher assumed the voice of Cosa. “Children, I am happy you woke me up, I missed all of you so much, I want to kiss you all one by one”; then, the puppet kissed all the children and us, we all laughed. Then, Cosa turned to one of the teachers and asked, “Bärbel, why do you have a guitar in your hand?”, and the teacher reminded Cosa that it was time to sing. They put Cosa in a chair and sang a role-play song. The children wore animal crowns, representing a cat, hamster, hedgehog, dog, and a rabbit. They played their own roles when the song was sung, the same song was sung three times so that other children can perform the different roles mentioned in the song. Then they all stood together, holding hands and sang a French song. Then Cosa returned and said, “children, I applaud you all, you sang the songs so well; then, Cosa sneezed. “I think I have a fever, oh I cannot even stand up properly”, and the puppet was turned upside down, and we all laughed. Cosa sneezed again and said, “I'd better go and have some rest,” and moved towards the cupboard, and said, “see you guys”. The children responded by saying get well soon and waving hands (Field Notes, Investigator).

In the framework of the problem-solving question the children were asked, three of the children's answers were evaluated at Level 1, three at Level 2, one at Level 3, and one at Level 4. As presented before, Ben Alex was able to comprehend the reinforcing loop in the system and provided solution to the problem accordingly: “I would hunt some animals, so the number of animals that use the water would be reduced” (Ben Alex). He was the only child who intended to control population growth to find a solution to the given problem situation, and his response was evaluated at Level 4.

4.3.4.3.7 Hidden Dimension

This dimension had the aim of assessing the children's ability to detect obvious and hidden components and processes in the system. In this aspect, it was deduced that the children generally responded at Level 1 and Level 2 but two children gave answers at Level 4. In order to explore the abilities of the children to look beyond the visible, they were asked these five different questions. One of the children who performed at Level 4 was Ben Alex again, the question and answer dialogue about this aspect was as follows:

- Where did the water come from? (response of Ben Alex: water came from the depths of soil)

- Why has the water decreased? Where did the water go? (response of Ben Alex: water was drunk, some of the water went to the bottom of the ground, and because the sun is drying the water, a little water goes up, into the clouds. Then, it comes down again as rain, comes up from the underground)
- Where did the animals go? (response of Ben Alex: To another place with water)
- Who/what else needs/uses water? (response of Ben Alex: plants and water springs)

Since this aspect is related to the root-causes thinking skill and subject matter knowledge, there are two issues to be considered. Two of the possible areas of supporting the hidden component is to talk about hidden components and processes in systems, and to talk about root causes. The indicator referring to ‘there are conversations about hidden components and processes in systems’ was not fulfilled in this case. Conversations that are deep enough to focus on root causes when constructing cause and effect associations are not also found in this case. However, imagination is a phenomenon supported in this case (see the efforts of the children wearing Native American Indian costumes to set up the Indian tent). Photo of the interest corner established to facilitate children's role-play processes is presented in Figure 55.

Figure 55. Pretend play corner

The second issue related to this aspect is subject-matter knowledge. Children having some prior knowledge of the water cycle is a factor which makes it easy to comment on hidden components and processes. Deducing from the conversations with the teachers, it was concluded that the children had not had any previous educational experience of discussing the water cycle, population, and animal migration in the A-GR preschool. Thus, the indicator referring to ‘subject-matter knowledge is very important in this learning environment’ was not fulfilled in this case, there was no educational content provided for children to develop the subject-matter knowledge. There was a special situation experienced in this case. Of all children, it was Ben Alex, who could describe the water cycle in the most comprehensive way, and he belonged to the A-GR case. In his interview, he was asked about the basis of his approach to water cycle. He stated that he obtained this information from a game called “nature quiz”. Thus, it was understood that Ben Alex was equipped with prior knowledge that could be helpful in establishing the water cycle as he did at Level 4 in the dynamic thinking aspect and that might assist him in identifying the movement of water in nature in a holistic manner with hidden components and processes.

4.3.4.3.8 Time Dimension

For the last dimension in systems thinking, the aim was to detect the children's ability to comprehend time and make a future prediction. In order to collect data in this area, an assessment was made as to whether the future prediction work was undertaken with the children in the field and if there were conversations about the past-present-future connection and about time in general. No clear evidence concerning time in general and future prediction in particular was obtained from the A-GR case. The conversations about past-present-future connection only included patterns for past-present connection while the children were read the book about Matida by the teacher. This book was suitable for reading over the course of several weeks, which means that the children must follow the story over time, and this is the only evidence from the A-GR case of encouraging the children to engage in comprehending time. Two of the children's future prediction skills were at Level 1 and five at Level 2 with no child performing at Level 3 or 4.

4.3.5 The Mainstream Education Cases from Germany with Higher and Lower Educated Parents (The M-GR-M Case and The M-GR-L Case)

4.3.5.1 Description of Educational Context at Meso Level: The M-GR Preschool

4.3.5.1.1 General Information about the M-GR Preschool

The M-GR preschool is located in the city of Berlin, in the east of Germany. This preschool provides services under the non-public and non-profit preschool status, and the monthly fee for each child is subsidized by the state (the subsidization principle also applies to the private preschools[31]). Since 1998, the M-GR preschool has provided ECE services for up to 130 children with different socio-economic status. The preschool defines its activities as follows:

> The main goal of our work is to prepare the ground for our children to be able to think and act independently and autonomously and develop social and environmental awareness. Here we orientate ourselves to the real-life of our children and to their personal processes of acquisition, because we think that early childhood education is linked to the immediate experience of the child (Concept Document of the Preschool).

The A-TR preschool occupies a physical area of approximately 1500 m² indoor space a 600 m² open area. The indoor space consists of two buildings and a bridge between these buildings. The buildings consist of a management room, a meeting room with a library, classrooms, a music room, a sports room and a multi-purpose room. There is a separate dressing room attached to each classroom, a toilet section with two toilets and a shower, and a small kitchen. In the outdoor area, there are areas of soil, sand and concrete, and various equipment, such as swings, slides, climbing wall, a rocking animal, water pump, bicycle, scooter, ball, and castle are offered for the children to freely use. Regardless of weather conditions, children are taken out to the outdoor area at least once a day. Children eat their lunch in their classrooms. Meals are cooked daily in the kitchen of the preschool, and 60% of the food products are organic products.

4.3.5.1.2 Pedagogical Approach of the M-GR Preschool

As with all preschools in Berlin, the M-GR preschool has a detailed conception document. The framework of this document is basically grounded on the documents of the *KitaFöG*[32]; Law on the Promotion of Early Childhood Education and Care under the Convention of the Children's Rights.

The basic principles of the education program written in the conception document are presented below:

- Children have a natural need for education and development and they have the right to be accompanied and assisted during this process.

[31] For more information please visit: https://www.berlin.de/sen/jugend/familie-undkinder/kindertagesbetreuung/kostenbeteiligung/

[32] For more information: http://www.kita-nordwest.de/docs/KitaFG.pdf

- Children shape their education processes actively by interacting with their environment and the people around them.
- Early childhood education is a process that involves improving children's social and emotional skills, language and cognitive skills, as well as their motor and self-care skills.
- We recognize that children's educational processes are complex and holistic in which sensory organs, body, language, feelings, thinking and memory are involved.
- For us, games are part of the educational process in which children have the opportunity to experience their limits and their peers' limits. Our responsibility is to provide children with a variety of experiences in terms of free play and interaction.
- For us, every child is an individual person and they have the right to be accepted and respected with their differences. As the partners and role models of children, we respect and value the children in our institution by seriously taking their problems, concerns and feelings into consideration.

4.3.5.1.3 Characteristics of the M-GR Preschool Staff

This preschool has an administrative team of two people. The preschool administrator is employed full-time and undertook administrative duties, as well as supporting learning groups when necessary, such as when teachers were ill or during break times. The deputy preschool administrator is working full time with duties divided equally between being a second group teacher and undertaking administrative work Apart from the administration team, the M-GR preschool has a staff of 19 teachers (assigned to nine learning groups) and a cook. Each learning group is assigned a main teacher and a second teacher. There are also teachers with different areas of expertise, working with children in all the groups or in small groups; for example, some teachers' specialty is language teaching, and their primary task is undertake individual language work with children whose mother tongue is not German and to support these children in developing their German language. The cleaning service is provided by an external organization. All the administrative and teaching staff members are senior educators, each having 15+ years of professional experience.

4.3.5.2 Description of the Cases

4.3.5.2.1 Profile of Adult Participants

Four adults from the M-GR preschool participated in the study; the administrator, the first and second teacher of the M-GR-L learning group, and the teacher of the M-GR-M learning group. All of them were female. The teachers had vocational high school degree and the administrator had university degree in the field of ECE. The administrator had 29 years of experience, the first teacher of M-GR-L had 36 years of professional experience, and the second teacher of the group had 39 years of professional experience. The teacher of the M-GR case had 30 years of experience. All the participants had been providing ECE services in the M-GR preschool for more than 10 years. At the time of the research, the average age of the participants was 53.

4.3.5.2.2 Profile of Child Participants in Case M-GR-M[33]

As shown in Table 36 and Figure 56, five girls and four boys from this preschool participated in the study, and most of them were monolingual. Regarding the parent's education level, at least one parent of all the children had a minimum undergraduate level of education. The mean ECE enrollment age of the nine children was 21 months.

Table 36. Profile of child participants from the M-GR-M Case

	Characteristic	Frequency	Percentage
Gender	Girls	5	55.6%
	Boys	4	44.4%
Age	48-59 months old	0	0%
	60-71 months old	7	77.8%
	72+ months old	2	22.2%
Bilingual	Yes	1	11.1%
	No	8	88.9%
Education Level of Parents	University degree or above	9	100%
	Less than university degree	0	0%
Mean ECE Enrolment Age: 21 months old			
Mean Age: 67 months old			

N=9

The mean age of the child participants from the M-GR-M case was 67 months. The gender and age distribution of the children are given in Figure 56:

[33] Attention was paid to arrange the visits of the cases while reporting. According to this order, the M-GR-M case was visited first and then it was later decided to include the M-GR-L case in the study.

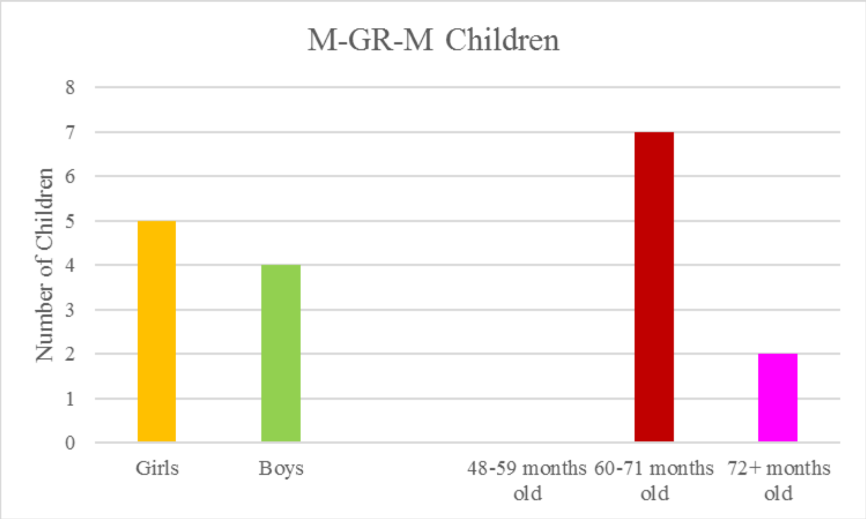

Figure 56. Gender and age distribution of children from Case M-GR-M

4.3.5.2.3 Profile of Child Participants in Case M-GR-L

As shown in Table 37 and Graph 57, eight girls and six boys from this preschool participated in the study, and most of them were bilingual. Regarding the parent's education level, at least one parent of four children had been educated at university; however, neither of the parents of ten children had a minimum undergraduate level education. The mean ECE enrollment age of the fourteen children was 25 months.

Table 37. Profile of child participants from the M-GR-L Case

	Characteristic	**Frequency**	**Percentage**
Gender	Girls	8	57.1%
	Boys	6	42.9%
Age	48-59 months old	0	0%
	60-71 months old	9	64.3%
	72+ months old	5	35.7%
Bilingual	Yes	7	50%
	No	7	50%
Education Level of Parents	University degree or above	4	28.6%
	Less than university degree	10	71.4%
Mean ECE Enrolment Age: 25 months old			
Mean Age: 67 months old			

N=14

The mean age of the child participants from the M-GR-L case was 67 months. The gender and age distribution of the children are given in Figure 57:

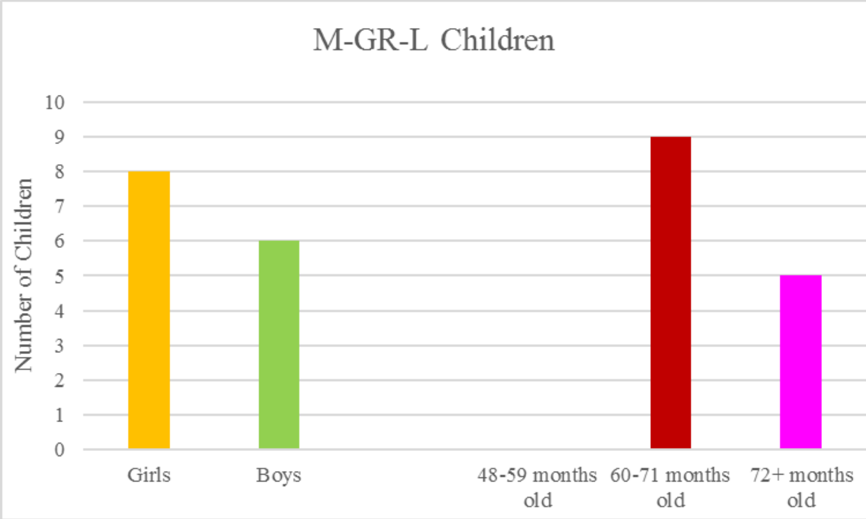

Figure 57. Gender and age distribution of children from the M-GR-L case

4.3.5.2.4 Preschool Climate[34]

In the first part of the checklist, the preschool's internal dynamics and the level of communication with the outside world are given under the section on preschool climate. Both of the cases in M-GR preschool fully fulfilled all the indicators (Figure 58).

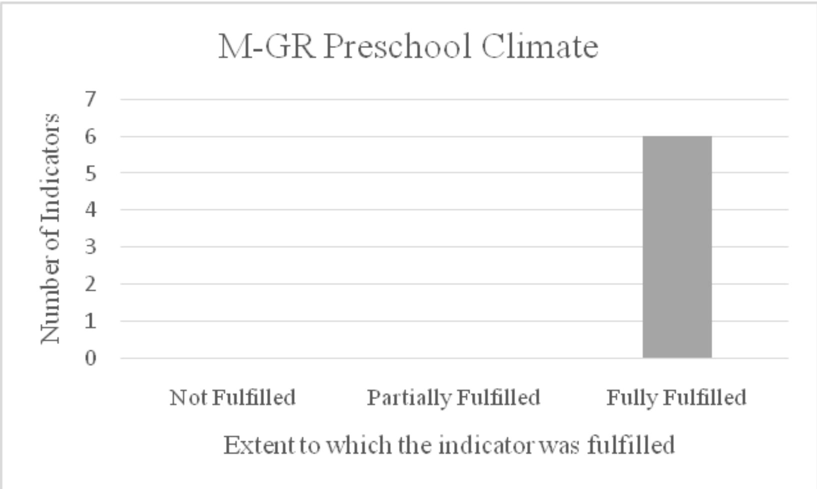

Figure 58. Preschool climate in both cases belonging to the M-GR preschool

[34] To clarify, M-GR-M and M-GR-L are two learning groups belonging to the same preschool. The M-GR preschool has a highly integrated approach to learning and development. Consequently, the functioning practices related with preschool climate, physical space and focus on sustainability indicators are similar in both cases. Therefore, all the criteria covered under these three headings are valid for both cases and reported collectively, including evidences from both of two cases.

In this preschool, opportunities for the administrators, teachers and parents to have a voice and be involved in all issues and themes that affect them are supported by institutionalized participation structures. As a result of the adult interviews that were undertaken, it was understood that the teachers who have expertise in the same age group had monthly meetings (branch meetings). Additionally, all the teachers and the preschool administration team came together four times a year to discuss the issues in the preschool with a common agenda they had agreed on. In each learning group, two parent spokespeople (*Elternvertreter*) were selected based on the parents' common decision. These people are in communication with the families in their group, act as a participatory body, and represent the entire group in discussions with the group teacher and preschool admin if necessary, and they are involved in all issues that affect them. All parent spokespeople meet with the preschool administrators twice a year. These participatory mechanisms between teaching staff, administration staff, and parent are clear evidence of the adults carrying out democratic forms of conflict resolution in the preschool. These mechanisms create the basis for solving possible conflicts in the process of formation. In addition, there is a clear approach to conflict situations among the adults in the M-GR preschool. The teacher of the M-GR-M learning group gave a detailed explanation of this issue:

> Conflict resolution methods vary according to the scope of the issue in question. If the issue is between two colleagues and they cannot resolve it on their own, a third colleague is invited to assist in reconciling. If a resolution cannot be achieved, then the administration is also involved in the case, and if the problem is still not resolved then, someone outside of the preschool is invited to assist in the process of conciliation. If the matter is related to a child and there is no common opinion, we invite an expert from outside the preschool to help us (Teacher M-GR-M).

The children are not included in the decision mechanisms for the general functioning of the preschool. However, it should be noted that this preschool was created with a child-centered perspective. In the context of a holistic approach to the preschool's applications, the interests of the children and their preferences have been taken into account in all the mechanisms in the preschool. In both learning groups, there is evidence that the children have engaged in some kind of conflict prevention work among themselves in concert with their teachers. In the light of the information that the teachers conveyed, it was concluded that the children discussed and agreed on the behaviors they wanted to see and they did not want to see in their learning groups at the beginning of the year. In both groups, the decisions taken by all the children were photographed and hung on the classroom walls to be visible to all the children. Similarly, rules about playing soccer were discussed with children. These rules written out by the teachers; then, the children signed them and the paper was pinned up in the classroom (Figure 59).

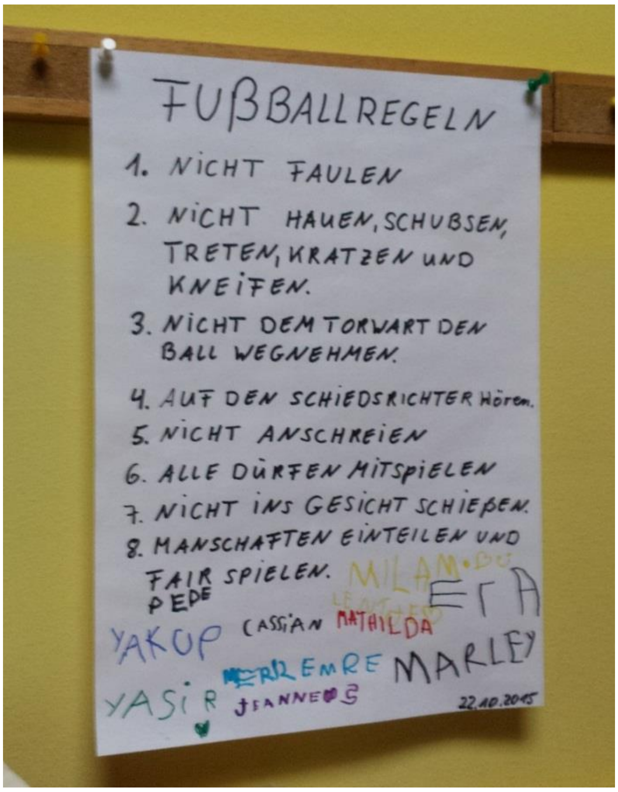

Figure 59. Football rules signed by the M-GR-L children

Hence, it was concluded that in this preschool, the children act out democratic forms of conflict resolution in their learning groups. Adults who work at preschool stated that they regularly hold staff feedback and consultation sessions and engage in an exchange of ideas on many issues. Additionally, teachers explained that they could conduct most of the consultation sessions in short negotiations while children were playing in the outdoor playground.

In the M-GR preschool, there is a comprehensive approach to staff development and training Every teacher in the preschool has to take an in-service training program at least once a year[35], and what they gained from this training is transferred to their colleagues through presentations done in staff meetings. In order to open up external spaces for

[35] The costs incurred by the in-service training are covered by the preschool budget.

experience and learning, the preschool works in close cooperation with individuals, organizations, and authorities outside the preschool:

> We meet once a month with administrators of other preschools in our own region. From these meetings, we gain ideas for giving a richer experience for our children. Children go on field trips almost every week, visiting different museums and exhibitions, and they make field visits to support the topics they have learned about. We are also in cooperation with a primary school and nursing home in our neighborhood, and we regularly visit these institutions with the children. The two older groups have a swimming lesson in our local public swimming center every week. Lastly, we have developed close cooperation with the children's families. We very often invite them to this learning environment and they support our work. We attach great importance to children being involved in art activities, we monitor all the theater performances and different art works in the surrounding area (Administrator, M-GR Preschool).

Next part of the thesis presents the contextual description of the M-GR-M and M-GR-L cases within the framework of the indicators presented in the Sustainability and Systems Thinking Indicators Checklist.

4.3.5.2.5 Physical Space

In this section, in M-GR-M, five of the seven indicators discussed under this heading were fully fulfilled, one was partially fulfilled, and one was not fulfilled (Figure 60).

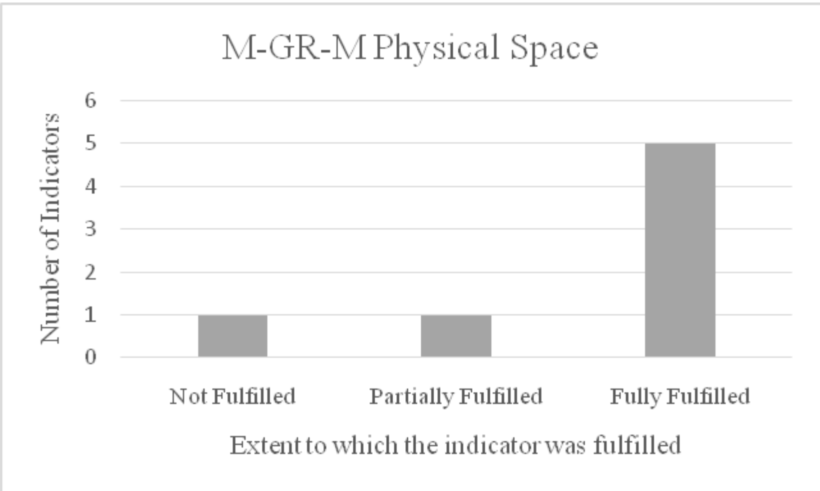

Figure 60. Physical space in M-GR-M

In the M-GR-L case, six of the seven indicators discussed under this heading were fully fulfilled and one was partially fulfilled (Figure 61).

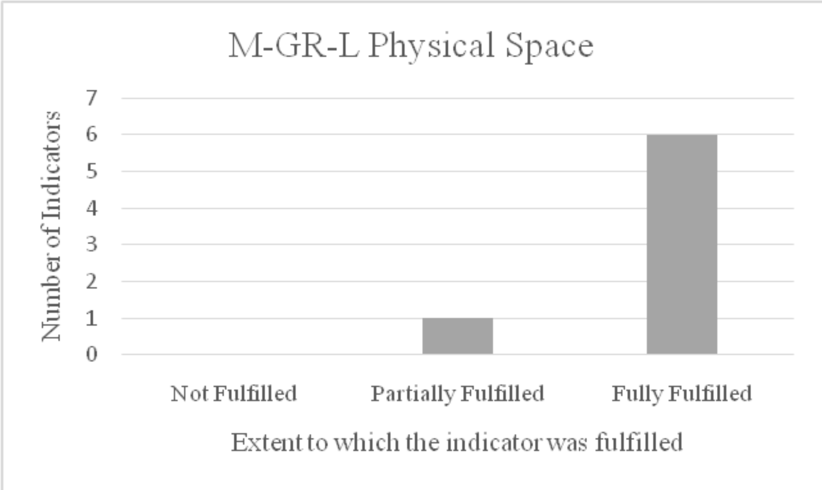

Figure 61. Physical space in M-GR-L

In the M-GR preschool, there is a traditional approach to the use of physical space. Each child is assigned a classroom and specific teachers along with peers close to their age group. However, for some children, these possibilities have been further expanded:

> We saw that the physical space that children can access is not limited to only the classrooms. In the morning, the children bring breakfast from their homes. Every day, the children eat their breakfast in different classes with children from different age groups until the circle time in their class starts at 10 a.m. In this process, free play is possible while breakfast is being eaten. The teachers participate in this free play with the children. Children who will be picked up by their parents after 4 p.m. are gathered in a different class every day and engaged in free play until their parents arrive (Investigator, Field Notes).

As a result of the interviews and observations, it was concluded that the children who come to the preschool late in the day and leave early spend all day in the same indoor classroom, but those children who spend a full day at the school benefit from the opportunities of visiting different classrooms. However, at the time of the observation, there was virtually no child who came late to the preschool and left early. Children are also taken to the sports room and music room at certain times. As a result, even though it was concluded that children have access to most parts of the indoor environment, it was decided that this criterion is partially fulfilled when compared to the A-TR and A-GR cases, in which all children were free to explore all parts of the indoor environment. As previously stated, children are taken outdoors every day regardless of the weather conditions. During this time, children spend free time free and have access to all parts of the outdoor environment. In the preschool, there is a rich and abundant amount of materials that children can use in many ways. The children are given the time and space to use the materials. A significant portion of the materials is positioned so that they can be accessed by the children. There is a method developed by M-GR preschool and put into practice in every class, which consists of marking the place of all materials with picture cards so that children can use and replace all materials themselves without adult supervision as shown in Figure 62:

Figure 62. Some of the materials with the picture cards

In both classrooms of the visited cases, systems are illustrated in the learning environments through different posters. These posters include images of the world and maps of Germany, body images of the skeletal-vascular-nervous-muscular systems, solar system, and architectural studies (Figure 63 and 64):

Figure 63. Posters illustrating systems

Figure 64. An architecture study as evidence of an illustration of systems

There is a difference in the final criterion between the two cases. In the class of M-GR-M, systems are illustrated in wall displays and children are able to see them, but they cannot touch the systems. In the M-GR-L class, children are able to see and touch the systems, because live systems are created in a corner of the classroom, one being the isopod terrarium and the other being the larvarium (Figure 65).

Figure 65. Isopod terrarium and larvarium in M-GR-L classroom

4.3.5.2.6 Focus on Sustainability

There are nine indicators discussed in this part of the report. In M-GR-M, four of the eight indicators discussed under this heading were fully fulfilled, four were partially fulfilled, and one was not fulfilled (Figure 66).

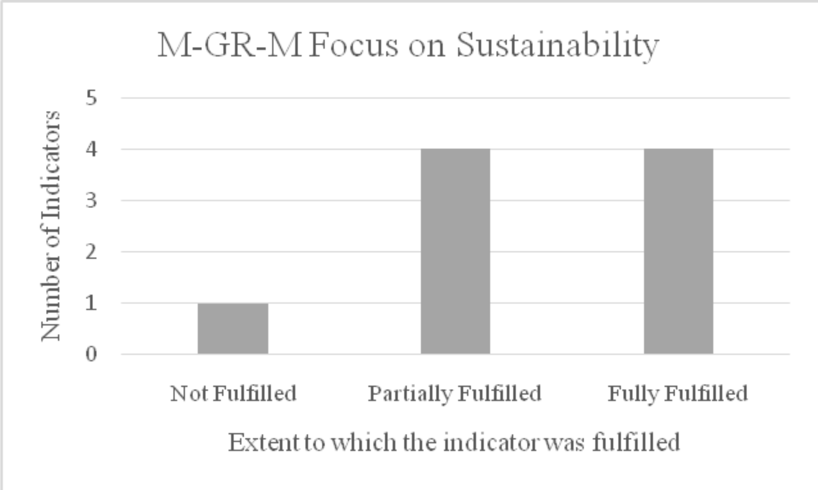

Figure 66. Focus on sustainability in M-GR-M

In the M-GR-L case, five of the nine indicators discussed under this heading were fully fulfilled and four were partially fulfilled (Figure 67).

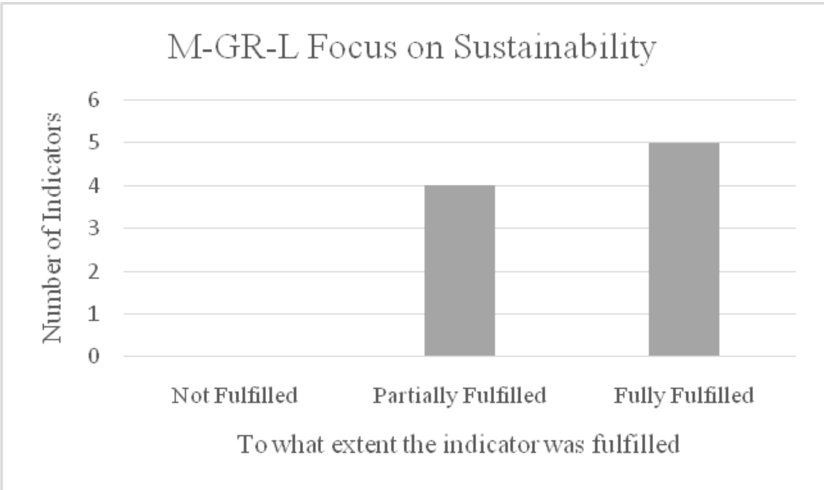

Figure 67. Focus on sustainability in M-GR-L

Both the practices of the M-GR-M and M-GR-L cases were in partial agreement with the theories and concepts of sustainability. Most of the work undertaken comprised activities that were similar examples in the curriculum of the Ministry of National Education in

Turkey within the context of science and nature activities. In the M-GR cases, the level of the sustainability topics coverage was lower than the A-TR case but higher than the A-GR case; accordingly, it was concluded that sustainability topics are partially integrated into internal preschool teaching plans and curricula in the M-GR preschool. It was concluded from the interviews that most of the adults including the teacher of the M-GR-M case in the preschool had not received pre and/or in-service training in the fields of ESD, EE and EfS. However, it should be noted that the second teacher of the M-GR-L case has extensive knowledge in the field of nature, and she said that she participated in many in-service training events in this field. Accordingly, it was concluded that M-GR-L case partially fulfilled indicator on pre and/or in-service trainings in the field of ESD, EE and EfS.

The preschool's purchasing policy is neither fully sustainable nor completely unsustainable. When making purchases for supplies and equipment for the preschool, there is a clear preference for buying durable and high quality materials. There is also a clear criterion in the purchase of food; in the preschool, 60% of the dishes are prepared using organic products. The staff of the preschool try to manage resources carefully by reducing, reusing, and recycling. As realized in the case of A-GR case, separating garbage in the source activities for children is organized in every classroom in the framework of the Garbageman (*Müllmann*) activity organized by the municipality every year. There are three color-coded garbage cans in every classroom, and all the children and adults dispose of garbage appropriate to the color. Using reused and recycled material from nature and daily life is common in the preschool (Figure 68):

Figure 68. Musical instrument created by children using recycled materials

As with the case of A-GR, diversity is one of the important components of this preschool. Adults show acceptance of people in their differences. As stated in the conception document:

> Every child is an individual person and they have the right to be accepted and respected with their differences. As the partners and role models of children, we respect and value the children in our institution by taking their problems, concerns and feelings into consideration seriously (Conception Document, M-GR Preschool).

Adults provided the definition of the term in a multi-dimensional way. As the second teacher in the M-GR-L case stated, “When diversity is mentioned, the things children bring to this preschool come to mind, such as cultures, languages, life perspectives, and lifestyles; this is diversity for me”. The other definition of diversity given below belongs to the M-GR-M teacher:

> For me, diversity means providing different opportunities for children, supporting them to enjoy their lives freely and infinitely. If the child's family does not have the financial possibility, this is even more important. Some of our basic goals are to provide the child with opportunities to support different developmental areas, play sports, engage in music, engage in a cultural program, express themselves freely, and develop their visions by participating in field visits (Teacher, M-GR-M).

It is important to note that in both learning contexts, the cultural backgrounds and socio-economic status of the people are very different from each other; so, there is a substantial opportunity to appreciate a rich cultural diversity in this sense. As with many preschools in Berlin, it is possible to meet people of every color and from every nation in this preschool. This feature is regarded as a richness by the preschool and cultural education is an important focus. Country festivals realized with the participation of the families and the emphasis on the different languages, cultures and religions in the daily flow are among the activities organized in this context. The second teacher of the M-GR-L case stated, “We have many workshops focusing different nationalities, we arrange country festivals, we organize visits to different embassies, we attach importance to national holidays, and we celebrate them with notices on our board”.

Further evidence of the focus on cultural diversity was seen in the posters prepared in two of the classes that were observed concerning the explanation of colors and numbers in different languages (Figure 69):

Figure 69. Posters related to different languages

The last indicator under this heading is 'adults provide children with the opportunity to learn, appreciate and compare diversity in nature'. This indicator was partially met in the M-GR-M case and fully in the M-GR-L case. The difference in the fulfillment of this indicator is due to the competency differences of the teachers who were assigned to the two groups[36]. The second teacher assigned to the M-GR-L learning group had a specialism in nature and she has attended many in-service training programs in this field. She regularly organizes activities in this area for the children in the M-GR-L learning group. She takes care of the isopod terrarium and the larvarium demonstrated before and she also puts up various posters in the classroom concerning the natural world.

[36] There are three teachers assigned to the M-GR-L learning group. The teacher responsible for the general functioning of the class (referred to as the first teacher) worked 40 hours a week. The assistant teacher (referred to as the second teacher) worked 20 hours per week, supported the first teacher by undertaking classroom teaching in her absence, and conducted activities on nature. The third teacher assigned to this class was referred to as an integration teacher, who taught the children German three times a week.
Three teachers were normally assigned to the M-GR-M learning group. However, the second teacher working part-time was on maternity leave. Since the number of bilingual children in this learning group was low, the language teacher (integration teacher) was working individually with some children, rather than the whole group. As a result, a single teacher was generally responsible for the functioning of the entire M-GR-M learning group, and she openly stated that she was not satisfied with this situation.

4.3.5.2.7 Approach to Learning and Experiences (M-GR-M)[37]

There are six indicators discussed in this part of the report. In the M-GR-M case, all of the six indicators discussed under this heading were fully fulfilled (Figure 70).

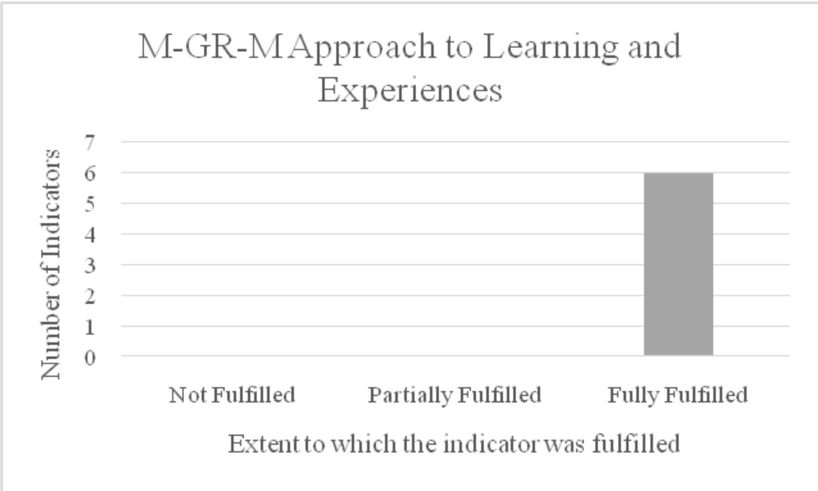

Figure 70. Approach to learning and experiences in M-GR-M

In this learning environment, the learning experiences were strongly linked to other learning experiences, deep project learning was utilized in the case. During the observation period, in this case, a project in operation concerning musical instruments was closely followed. An observed session of the project is described below:

> The teacher greeted the children and asked, "What did we do last week?" The children replied, "we went to the bell museum". The teacher asked, "what did we do there?", and the answer was, "we tried to play the instruments". In response to which instruments were available in the museum, the children gave a wide variety of answers. The story of who plays an instrument and which instruments are played in the family emerged by itself, and the children and the teacher briefly discussed this topic. The teacher reminded the children that the instruments belonged to certain groups and asked which group the violin, cello and contrabass belonged to. After she received the answer, she asked which group the piano and org belonged to. After listening to the answers, she asked what material the flute was made of, and one of the children replied "wood". The teacher was wearing a t-shirt with African figures on it. The teacher put the instruments she brought to class in the middle of the group of children as shown in Figure (71). The instruments were different from the classical western music instruments:

[37] Indicators under the headings of approaches to learning and experiences, thinking and acting routines and systems thinking are reported separately for each case. However, since there were some common applications in both cases, details of those commonalities were explained in one case and some references were made to those commonalities in the other case.

Figure 71. Instruments brought by the teacher

One by one, the teacher introduced the instruments to the children, showing how they were played; the instruments were passed around and the children tried to play them. After introducing each instrument, the teacher asked the children to suggest what group the instrument might belong to. When the children responded, she asked the question, “why did you think this instrument belonged to that group” and gave the children an opportunity to produce reasons. The teacher focused carefully on the cactus rain stick, because children were very curious about this instrument. Without giving the name of the instrument and what it was made of, the teacher asked children to describe the sound of the instrument, and the children associated it with the sound of rain. The instrument was handed to the children one by one, and they tried to play it. The teacher wanted the children to guess the name and material of the instrument asking them, “What is on it?” and “what could be found in it?”. She wanted them to develop ideas about which instrument group it might belong to. Later, she gave children detailed information about the instrument: the instrument was made from a cactus; it was dried, the outside thorns were cleaned and polished, and the thorns inside were left inside. Later, small stones and beads were placed in it and closed. The teacher asked what would happen if it had not been closed, children said the instrument might not function. Then, the teacher asked each child to find the drums (Figure 72) they had created the week before.

Figure 72. Drums created by the children

She also placed a djembe, a rope-tuned skin-covered goblet drum, in front of her and introduced the instrument to the children explaining that it was an African instrument. The teachers asked the children to raise their hand and say which animals are found in Africa. Then, the children they started to make sounds on the drums they had made. The teacher asked how they could make a snake sound with their drums, and the children slowly moved their fingers over the drums. When asked how they can make a mouse sound, they quickly tapped their fingers on the drum. When asked to make a camel sound, they made small taps and beat the drums. She then asked about the sound of a lion. The children strongly beat their drums. Then, the teacher asked the children once again to make sound like snakes, mice and camels, with their drums. Finally, she said, “now, make the sound of a lion”, and while the children were beating their drums, the teacher turned her djembe over and roared into it. This made us all laugh a lot. The teacher told the children that they would also use the drums to tell an African story and she began explaining; Once upon a time there was a lion (the children strongly beat their drums), walking in the forest with his snake friend (the children made the sound of a snake). The hunters set up a trap for the lion, the lion fell into a net, and roared first (the children made the roar) and then cried (the children pretended to cry). The snake immediately called the mouse for help (the children made the sound of a snake with their drums), the mouse came (the children made the sound of a mouse) and cut the ropes with its claws and sharp teeth and saved the lion. The lion thanked the mouse and the story ended, saying that the little animal saved the big animal. The teacher told the children that they had free time, and said they could make some kind of cactus rain stick if they wished. Two girls were very interested in this idea, and the teacher gave them a cylinder made of thick cardboard, nails and a hammer. After briefly telling how to do it, she left the children to work in their own way. The children hammered the nails into the cylinder on their own (Figure 73). At that time, some of the children tried to use the instruments that the teacher brought, they made very loud noise, but the teacher never intervened. Four children went to the table soccer; two children walked through bridge connecting the class to the other building and started a game with the racket and ball. When we arrived the next day, the final version of cactus rain stick was shown to us (Figure 74) and we tried to figure out how it sounded. We also realized the existence of other instruments made by the children (Figure 75) (Field Notes, Investigator).

Figure 73. Early phase of the rain stick

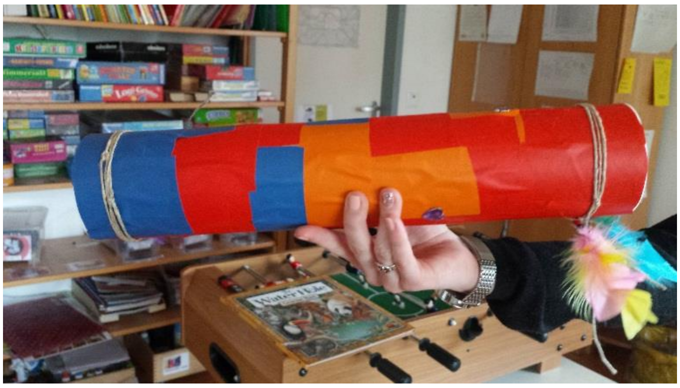

Figure 74. A rain stick made by the children

Figure 75. A musical instrument created by children

As explained above, the learning experiences in M-GR-M were designed to be multi-disciplinary with binding learning experiences to provide an inter-disciplinary transition. In this sense, it was concluded that an important part of children's learning experiences were multi-disciplinary and interdisciplinary.

The M-GR preschool has a clear view of the documentation of child development and learning. There are two basic documentation methods; first is the *Sprachlerntagesbuch*, a language learning diary, which is a part of the Berlin ECE curriculum. Completing this document on a regular basis was one of the priorities in the preschool. The second documentation tool used in preschool was a large folder (labelled as learning and development) in which entries were made from the first day the child starts at the preschool. When the child moves on to another group, the folder is handed over to the new teacher. This folder contains different documents from different activities conducted by the child and peers (Figure 76).

Figure 76. A child’s drawing after the visit to the musical instruments museum

These documents consist of the child's drawings accompanied by descriptions taken by the teacher in the light of the child's description, field trip notes and photographs, detailed documents written and photographed concerning other elements in different projects carried out in the group, as well as the individual projects and anecdotes written by the teacher about the child. The file structure was categorized according to the learning areas in the Berlin ECE curriculum. Even a brief look at this folder easily shows the connection between activities undertaken and the learning outcomes in the different areas of the curriculum learning (Figure 77).

Figure 77. Learning and development folders of the children

The investigator encountered this comprehensive tool before undertaking the teacher interview in the following way:

> One of the children took his development folder from the bookcase in one of the classes and presented it to us. He began to explain the contents from the first page, "I am still a baby here, this is my family, this is my favorite toy, here we went to a trip, I drew these pictures". As we wandered between the pages, the teacher arrived. She gave detailed information about the structure of the file and how to use it, and she explained that some of the work was undertaken with the voice recorder. The teacher explained that after some trips, they had engaged in open-ended questions with the children concerning the experiences gained in the trip in order to reflect, and they recorded these interviews. While one of the teacher was conducting the activity with children, another child was intently listening to these recordings. These interview transcripts are detailed and placed in the children's files, supported by the photographs from the trips. While interview transcription was being made, the teachers paid attention to language development issues such as the words used by children, sentence structures and mispronunciation. The teacher told us that in this way, they determined the issues in which the child needed to be individually supported especially in terms of language development (Investigator, Field Notes).

This documentation technique allows the children to fully observe their own learning processes over time.

4.3.5.2.8 Approach to Learning and Experiences (M-GR-L)

There are six indicators discussed in this part of the report. The M-GR-L case completely fulfilled all the indicators (Figure 78).

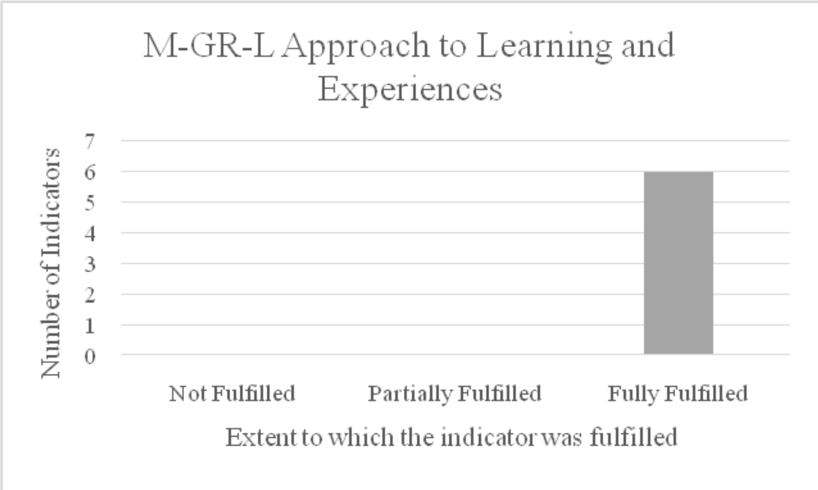

Figure 78. Approach to learning and experiences in M-GR-L

In this learning environment, the learning experiences are strongly linked to other learning experiences at Level III (project is utilized in the case). During the observation period, some evidence regarding project utilization and a highly qualified subject-spanning example was observed in this case:

> The teacher told the children that they were going to do an experiment together and she said that it would take some time to see the results of the experiment. She asked a child to bring some water, d told another child to bring the test materials on the table, and asked another child to bring two rulers from the ruler box. She put all the materials in the middle of the table and asked the children, “what are we going to do with these materials?” The children gave their suggestions, and the teacher listened each child. From a packet of jelly sweets, she showed one of them and said that Emre could not eat it, and then asked the children why. One of the children said, “cause there's pig gelatin in it”. The teacher said yes you are right; there is gelatin in this; then, she showed the packet of Jelly Tots and said “but there is no gelatin in these sweets; so, Emre can eat it”. The children were asked, “who wants to measure these jelly sweets?” One of the children measured the first jelly sweet as 2 cm. The teacher showed the other jelly sweet and asked if that was longer or shorter than the other. “It is longer. OK, if we measure this longer one with a ruler, will we get a larger or a smaller number?” “Greater.” They put the jelly sweet into the glass and glued it on the surface of the glass, and they drew a line on the glass to show the length of the jelly. When they were going to do the same for the Jelly Tot, it seemed that it was not sticking to the surface of the glass, and the teacher immediately asked, “this does not stick here, why?” It may be because there is no gelatin in it, said the children; it seems to be lighter than the other. “Now we will put water into these glasses; what will happen?” asked the teacher. The children anticipated that the jelly would float in the water. The teacher said it can be and explained that if the weight of the jelly sweet is less than the weight of the water, it can float. Meanwhile, one of the children said something to the teacher's ear and kissed her. Then, they put some water into the glasses, and the children were surprised because the jelly sweet did not float. One of the children recalled an experiment they did with a Vitamin C tablet and explained this experiment. The teacher told the children they could eat one jelly sweet from the packet and gave Emre a gelatin-free Jelly Tot; then, they put the glasses with the jelly sweets on the

> shelf. Two hours later, the teacher brought the children together and asked one of them to bring the glasses. After a short talk about the situation of the jelly sweets, they went out to the garden. The next day, after the morning circle, the teacher talked to the children asking them to recall the experiment they had carried out the day before. The children briefly summarized what was done. The teacher asked, "Now what do you think we need to do?", and the children said, "we need a spoon and a ruler". The teacher said, "bring them then". The glasses were put in the middle of the table again, and the teacher took out the jelly sweets from another packet that was similar to those that had been put in the water so that the children could make comparisons. They took the jelly sweets out of the water with a spoon and put the jelly sweet on a napkin. The teacher asked the children what had happened to the jelly sweet. The children said, "it's grown up", and when the teacher asked why, one of the children told that the water went into the jelly and swelled it. The napkin was handed around, and the children touched the wet and big jelly sweet. The teacher showed the jelly sweet from the packet and the one that had been in the water; then, she asked, "what kind of similarities and differences do these sweets have?" All the children made comparisons in turn, commenting that this one is cold, this one is wet, etc. The swollen jelly was put into the water again, stuck to the side of the glass and measured by the children. The teacher said, "look at the old line and the new line, how different they are". She said that they would leave the jelly sweet in the water and asked the children what they thought would happen. Each of them explained their estimations. One of the children said that she left a package of jelly sweets under the sun when she was on a vacation, and the sweets had melted. The teacher said that they could try that; next time they could make observations by putting the jelly sweet under the sun. The teacher brought the glass with the gelatin-free Jelly Tot. One of the boys said, "this jelly sweet is melting", and the children related this result to the lack of gelatin in the jelly. After lunch, they returned to the experiment. They saw that the jelly sweet had completely melted. "Where did the sugar go?" asked the teacher, and they concluded that the sugar had melted in the water. The teacher asked the children to taste the water and talked about the taste of it. The next morning, one of the children started talking about the experiment, and the children and the teacher talked about their experience together (Field Notes, Investigator).

Another project concerning a snowdrop, which had already begun before the process of observation, was closely followed in the observation period:

> The teacher recalled the promise she had given the children the previous week, saying, "as I promised, I brought you a snowdrop, I took it from the garden and planted it in this pot. Now, who wants to take this flower out of the soil?" One of the children gently removed the plant from the soil. They put a napkin underneath the flower in order not to damage it. Then, they handed the flower around and closely examined it. After the examination was completed, the teacher asked the following questions and the children responded to the questions while continuing to pass the flower from hand to hand: "what is the color of the root of this flower?", "what kind of roots does it have?, "did you pay attention to its leaves?", "what can you say about its leaves?", "what structure and hardness do the roots have?", and "what can happen if we do not return this plant to the soil?" The children replied that the plant could die, the color of the bulb could turn brown, the bulb could dry, and the leaves of the flower would fall. The teacher confirmed all these responses. The teacher then asked what for a flower needed to grow. After the children gave their ideas, the teacher briefly summarized: yes, rain, sun, soil, and wind that is not too strong. After the conversation was over, one of the children returned the plant to the pot. When they were leaving the classroom, the teacher reminded the children that they should take the plant. When they went out, they planted the

> flower together again in the garden of the school. At lunch time, the children remembered the poem they wrote together about flowers and spring. After carefully examining the classroom, we later realized that the snowdrop flower was a project which had been ongoing in this learning context. When the teacher took out the drawings of the children from the board, a hand-work study about the snow drop flower was under the papers. We also noticed the snowdrop flowers made by children using the origami technique hanging from the ceiling of classroom (Field Notes, Investigator).

There is a very interesting situation experienced in this case. The children were very curious and enthusiastic about the water hole story read in the child interview by the research partner. This situation did not escape the notice of the teachers. Towards the end of the observation period, the first teacher began to ask questions about how she and her children liked the book and where they could purchase it. While researchers were undertaking their observations, the first teacher borrowed and carefully read the book; it was understood that she took it to their colleagues and discussed it. The first teacher asked the children who finished the interview to draw a picture of the story that had been read to them, and when the data collection process came to an end, the pictures drawn by all the children were gifted to the investigator. As a result of the teacher's curiosity about the book, the investigator gave the book containing the Water Hole story as a gift to the teacher, because there is no German version of the story book on the market. After the observation period ended in the M-GR-L case, the preschool was visited a week after to interview with the preschool administrator, and the two learning groups were briefly visited. Both the investigator and the research partner were very surprised to see that they were working on a project about water hole in M-GR-L (Figure 79):

Figure 79. A photo of pictures drawn by the children concerning the water hole project utilized in the M-GR-L case

On completion of the study, the researchers went to talk to the teachers of the M-GR-L group to discuss the special features of the M-GR preschool. During this meeting, the first teacher explained that the storybook was multi-layered, and they could undertake very different activities based on the story, approaching the issues in the book from different angles. They explained that one of the topics they discussed with the help of the book was about animal species and habitats. In addition, the geographic locations in which animals in the book lived were also focused on. The study of emotional expressions was realized with the help of the little frog drawings in the book. The underlying problem in the story was discussed for a long time, possible solutions were analyzed with the children, and a new story was reconstructed as the project's closing activity. The teachers explained that the work was also shared with other learning groups in the preschool, and an opportunity was created for the children of this case to explain the experience they had engaged in to their peers.

As explained above, the learning experiences in M-GR-L were designed to be multi-disciplinary with binding learning experiences to provide an inter-disciplinary transition. In this sense, it was concluded that an important part of children's learning experiences are multi-disciplinary and interdisciplinary.

The documentation techniques in the M-GR preschool are described in detail in the relevant section of the M-GR-M case narrative. As a result, it was concluded for this case that both language learning diary (*Sprachlerntagesbuch*) and the learning and development folder enable children to observe their own learning processes throughout time.

4.3.5.2.9 Thinking and Acting Routines (M-GR-M)

There are 12 indicators under this heading. In M-GR-M, ten of these indicators were fully fulfilled, and two were partially fulfilled (Figure 80).

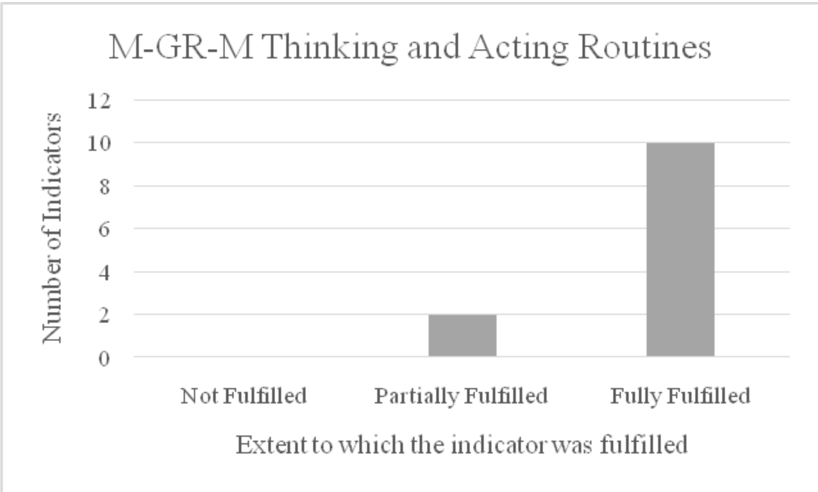

Figure 80. Thinking and acting routines in M-GR-M

In this learning context, the teacher mostly asked cognitively challenging questions. The questions posed to the children were mostly of a reordering or inferring about perception (Level III) type and reasoning about perception involving predictions, problem solving, and concept explanation (Level IV). The questions given in the field notes on the project related to the musical instruments are the proof regarding the conclusion reached concerning the cognitively challenging questions. For example, by showing the exotic musical instruments that the children had never seen before, the teacher wanted them to guess which of the groups of instruments they had previously learned about this instrument could belong to and created the opportunity for discussing the decision they offered. A similar approach was encountered in the making volcano experiment:

> Putting a tray with various items in the middle of the circle of children, the teacher announced that they would undertake an experiment, Each item was picked up by a child and handed on to the next child. They smelled the liquid items and put forward ideas about what the material was and how it could be used. For example, when examining a colorless liquid in

> a glass of water, the teacher asked the children about what this material might be, and a child gave the answer, “water with gas”. The teacher asked the child how he had surmised this. The child showed small bubbles sticking to the surface of the glass and said that was why he thought that the material was water with gas. The teacher asked the same child to taste the liquid, and he said, “it is not gaseous water, it is normal water”. They examined the dropper. The teacher asked, “how could this item be used?”; one of the children replied, “by squeezing”. The teacher handed the child the dropper and a glass full of water and told her to try. The teacher explained the working principle of the dropper when the girl was trying to use it, “Before the dripper is squeezed, there is air in it. When we squeeze it, the air goes out and water goes in”. She said that they could try to use the dropper, and in turn, the children filled the droppers with water and it dripped onto their arms and clothes. When the examination of all materials was completed, teacher asked, “So, what can we do with these materials?”, and the children expressed their suggestions. The teacher prepared a volcano from play dough and asked, “What comes out from a volcano?” “It’s a hot thing.”, “Do you know its name?” After receiving the answer of “lava”, she asked the children how this process happened, but the children said nothing. The teacher explained in detail that the layers with rock-soil in the earth are broken by the movements of the continents; then, the hot lava flows out of the depths of the earth. Then, by giving directions to the children, they combined the materials and made a kind of working volcano model, a colorful foam overflowed from the volcano. After a general roundup by the teacher, the children collected the materials. After lunch, the teacher distributed the same materials they used in the morning, and each child made their own volcano and undertook different experiments with the materials and showed their volcanoes to the other children (Research Partner, Field Notes).

In the experiment described above, children were asked what they could do with the material, and they made predictions and concept explanations about how to use the materials. There was also an opportunity created for the children to make judgments.

As demonstrated in the previous examples presented, children were allowed to talk freely and the adults created opportunities for a range of viewpoints. Within both the supervised activities and free-play time, children were able to converse freely with the teacher and each other. During those times, the children asked many questions and the adults listened to and encouraged children’s thinking in an engaged way.

The teacher of this learning group created open-ended experiences to foster creativity. In general, it was concluded that creative thinking was fostered in this learning context, confirmed by the following observation:

> The teacher told the children, “open your ears, close your mouth, I will play six different sounds to you, listen carefully, do not talk in the meantime”, then she started the tape recorder. The sounds were open to interpretation in many different ways. The children listened to all the sounds carefully and immediately raised their hands after the recording ended. “Now everyone can offer an idea about one of the sounds and let the other children say something, too” said the teacher. . The teacher asked the children who had not responded about their ideas. Then, the children listened to all the sounds again, this time talking about

> each sound one by one. After listening to the sound of walking, the teacher asked the question, “what kind of a person can walk like this? Where can s/he walk?” They listened to the sound of water, and the teacher asked what that sound was. One of the children told that someone was taking water from somewhere. The teacher said, “Well, can you show us? How can s/he do it?” She demonstrated it with movements. The teacher said, "OK, then why might s/he take this water?", and the children gave different answers. Children likened one sound to that of fire. The teacher said, “How can a fire be made?” One of the children said it could be done with a match. On hearing this, the teacher gave a detailed explanation of the logic behind making a match and how it was used. When all the sounds were discussed, the teacher said the children that they had completed their work and could engage in play free (Field Notes, Research Partner).

Even though focusing on individual children or creating small groups to engage in deeper understanding were not observed by the investigator and her research partner, the teacher mentioned that from time to time she provided these kinds of opportunities to the children, especially in terms of enhancing the German language capacity of children. So, it was concluded that this indicator was only partially fulfilled in this learning environment. Evidence regarding wrap-up or reflection exercises at the end of the activities were found in the learning and development folders of the children. At the end of each project, field trip, and different learning experiences that the teacher considered necessary to be documented, the teacher prepares reflection papers including studies made for this child's file and a detailed explanation of the child's role in this study. These papers are written in daily language and supported with photographs. The relationship between the curriculum and the activities undertaken are emphasized in another part of the documentation. These reflection papers are discussed individually with children, and opportunities are created for them to talk about the items in the folder. Figure 81 shows a document placed in a child's file related to the trip to the instrument museum[38] :

[38] In the first part of the document aforesaid, the things made in these trips are explained. In the second part of the document, the learning outcomes targeted to reach at the trip are listed. At the end of the document, the photographs taken of the child in the study are included.

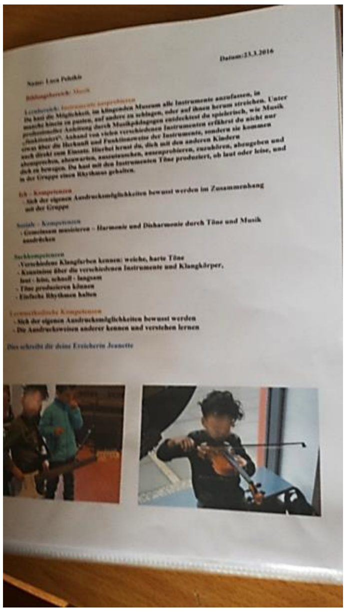

Figure 81. Summary of the field trip pertaining to an individual child

Adults displayed flexibility while creating learning opportunities indicator was partially fulfilled in this case. This was because rather than during observation, the evidence supporting this view was found in the responses of the teacher in the interview:

> I am not someone that dictates to the children; the children have equal rights in this environment. They can always freely express their opinions and wishes. I create the opportunity in the morning circle, especially for this process. The children can easily tell me what and how they want to do something, or I sometimes closely listen to what they are talking about. I ask the children about the issues they are dealing with, whether we should take a trip for this topic, build something or just focus more on this subject. It is very important for me that children focus on a topic, and they will need this skill in future when they move to the next school (Teacher, M-GR-M).

As can be seen from the different learning experiences described above, the indicator referring to adults providing the children with the space to participate in decision-making processes in line with their age and abilities was fully fulfilled in this learning context. The children's views and curiosity are some of the things that are central to this learning environment. In this preschool, adults encourage children to use their initiative and do whatever they can on their own according to their age and physical skills[39]. The preschool administrator underlined this issue carefully in the interview: "The two most important fundamental skills we focus on this preschool are first, self-sufficiency, and second,

[39] Other evidence supporting this view is the opportunity created for children to work with big nails and adult hammers on their own in making the cactus rain stick detailed previously.

language”. This statement was verified through the observations regarding the mealtime routines of both the M-GR-L and M-GR-M cases:

> In this learning environment, there is a table attendant (*Tischdienst*). Every day, three children are allocated to be the table attendants for lunch, and the teacher announces the names of these children in the morning circle. While other children go into the garden to play a game, the table attendants clean the tables with a clean cloth by filling a bucket located in the toilet with water. They prepared the table for all the children and teachers laying out the crockery and cutlery from the shelves in the classroom (Figure 82), then put on their outdoor clothes and joined the other children in the garden. When the mealtime came, the food was delivered with a service cart by a member of staff and left outside the classroom. The table attendant children brought the service cart into the classroom, leaving the serving containers on both ends of the table. Then, each child took food onto their own plate. The table attendant children were thanked for presenting the meal, and after saying “enjoy the meal”, children started to eat the food. The children chatted freely during the meal. Those who finished eating put their plates, cups and cutlery in the slots on the service car and started to play freely. The meal routine ended with the attendant children cleaning the tables and taking the service cart to the front of the classroom (Research Partner, Field Notes).

Figure 82. Crockery and cutlery in every classroom is organized in a way that children can access them on their own

As in the case of A-TR, in both learning groups in the M-GR preschool, the children engaged in free play and constructed activities in a balanced way. When compared with M-TR, in these three cases, it was concluded that children were provided more time and space for free play. However, free play was relatively less realized in the M-GR cases compared to A-GR. In this respect, it was concluded that the indicator referring to free play is extensively encouraged by adults was partially fulfilled in both the M-GR-M and M-GR-L cases.

4.3.5.2.10 Thinking and Acting Routines (M-GR-L)

There are 12 indicators under this heading. In M-GR-L, 11 of these indicators were fully fulfilled, and one was partially fulfilled (Figure 83).

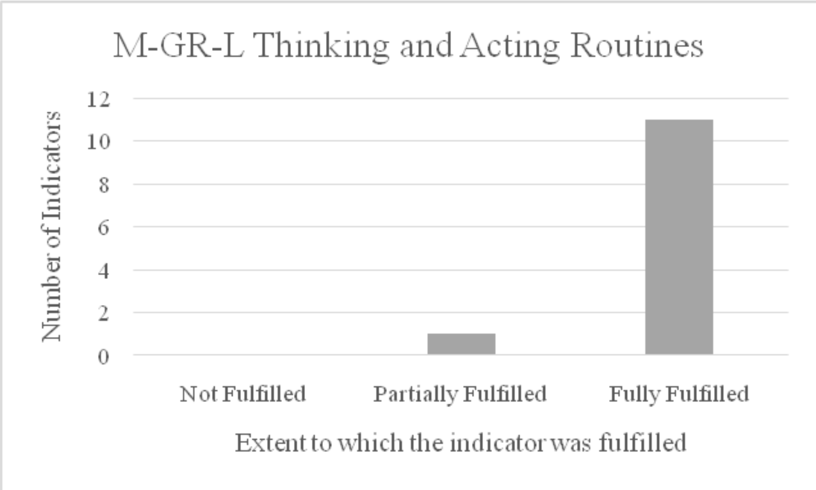

Figure 83. Thinking and acting routines in M-GR-L

In this learning context, both the teachers mostly asked cognitively challenging questions. The questions posed to the children were usually of a reordering or inferring about perception (Level III) type and reasoning about perception involving predictions, problem solving and concept explanation (Level IV) type. The many questions noted in the jelly sweets experiment are the proof supporting this view. The children made predictions in each step of the experiment; an opportunity was created for them to discussion their opinions and compare-contrast exercises; thus, concept explanation was undertaken.

As demonstrated in both the jelly sweet experiment and the examination of the snowdrop, the children talked freely and the adults created opportunities for a range of viewpoints. During the supervised activities and free-play time, the children were able to converse freely with the teacher and with their peers. During those times, children asked many questions and the adults listened to them and encouraged the children’s thinking in an engaged way. The teachers of this learning group created open-ended experiences to foster creativity. In general, it was concluded that creative thinking was fostered in this learning context. This is confirmed by the following observation recorded during the language development activity conducted by the language teacher:

> The teacher said that they would read three books today. Looking at the list in her hand, she named three children. She put a basket full of books in front of the children and asked the chosen children to choose a book they wanted to read. After the selection was over, she told

> one of the children to sit in the chair, and the other children sat in a circle on cushions on the floor. The teacher gave the instruction, “OK, Imani, now I want you to read the book you chose to us and use the pictures, as well. You can examine all pages before if you want, and then you can start reading the book. Do not forget to ask us questions from time to time while reading the book to us”. The child calmly examined the book; then, like an ECE teacher, she created a story showing the pages of book to other children and the teacher. During this process, she remembered to ask her peers questions her and they laughed from time to time (Research Partner, Field Notes).

Both the researchers found this exercise very impressive. The investigator wrote following notes in her reflexive journal: “The children's reading activity to the children was very impressive and I might say that my eyes are full with tears. I was amazed at the breadth of children's capacities and imagination” (Reflexive Journal, Investigator).

In this learning group, the adults focus on individual children and create small groups for deeper understanding. The fulfillment of this indicator is provided due to the presence of a team of three teachers. While one teacher is engaged in activities with the large group, the other teacher(s) are able to carry out development studies with individual children or in small groups, where deemed necessary[40]. Evidence regarding the wrap-up or reflection exercises at the end of the activities were found in the learning and development folders of the children. This approach is similar to that observed in the M-GR-L case. In addition, the classroom teacher gives assignments at the end of each project for the children to work on collaboratively. This creates meaningful opportunities to further deepen the reflection process (Figure 84).

The adults displaying flexibility while creating learning opportunities indicator was fully fulfilled in this case. The evidence to support this view was the emergence of the water hole project. Even though the teachers had other educational plans, they accepted the children’s wishes, and thus the water hole project was begun together.

[40] The number of the staff of the preschool also allows the teachers enough time and space to undertake the documentation.

Figure 84. Work on the water hole project created collaboratively by the children

As can be seen from the explanation made on the M-GR-M case, the indicator referring to adults providing the children with space to participate in decision-making processes in line with their age and abilities was fully fulfilled in this learning context. The children are seen as decision-makers and everything that children can do on their own is left to them in the preschool, and adults fully encourage children to do things for themselves. For example, as in the case of M-GR-M, suitable environments have been created for children to use different tools on their own (Figure 85).

Figure 85. Repair and construction equipment in the M-GR-L classroom

Finally, the indicator referring to free play being extensively encouraged by adults was partially fulfilled in the M-GR-L contexts. The description of this subject is detailed in the related section in the M-GR-M case.

4.3.5.3 Systems Thinking Skills of M-GR-M and M-GR-L Children

In this part of the case study narrative, there is a specific focus on the evidence found in the educational context that can be related to the Systems Thinking Developmental Rubric for K-Level. In this regard, the children's level distributions in each aspect of the M-GR-M case are presented in Figure 86.

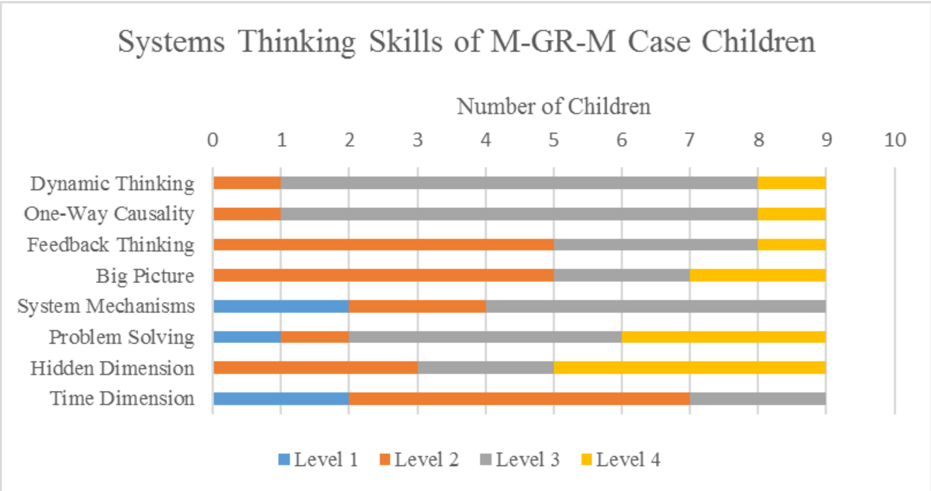

Figure 86. Systems thinking skill levels of children from M-GR-M case

The children's level distributions in each aspect of the M-GR-L case are presented in Figure 87.

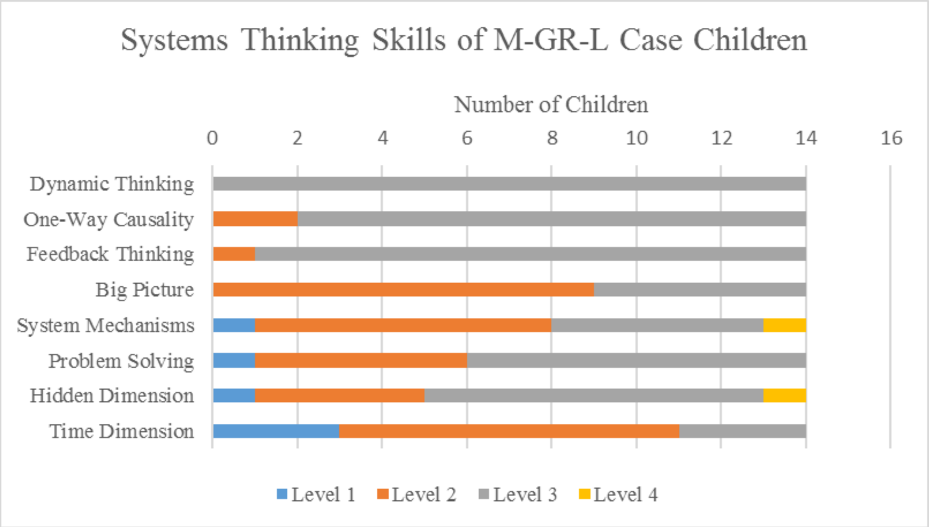

Figure 87. Systems thinking skill levels of children from M-GR-L case

In this part of the study, 17 indicators are evaluated. M-GR-M did not fulfill five of these indicators, partially fulfilled five, and fully fulfilled seven (Figure 88).

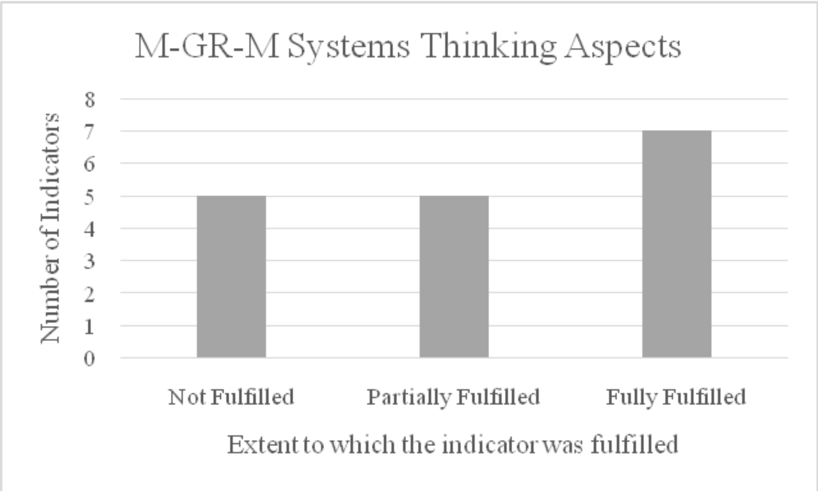

Figure 88. Systems thinking aspects in M-GR-M

M-GR-M did not fulfill five of these indicators, partially fulfilled four, and fully fulfilled eight (Figure 89).

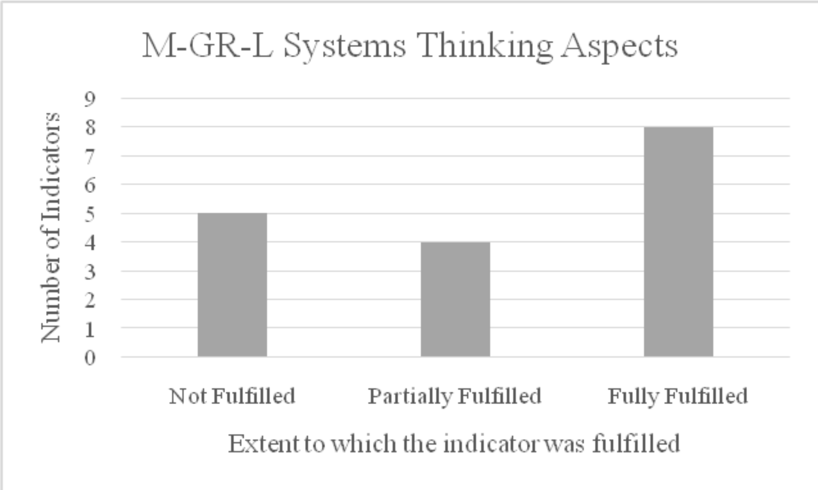

Figure 89. Systems thinking aspects in M-GR-L

4.3.5.3.1 Dynamic Thinking

In this aspect of systems thinking, the aim was to detect the children's dynamic thinking ability concerning whether they could understand changes in the components and processes that construct obvious and hidden patterns in the system. There were some previous practices in both cases which supported the children in solving the pattern in the book that was discussed in this study and allowed them to comment on the gradual change in the amount of water. These practices generally consist of worksheets taken from different educational books. The indicator referring to 'there are educational materials concerning the use of mathematical reasoning exercises such as numeration, pattern building and discrimination of size' was fully fulfilled in both cases. The measurement attempts in the jelly sweets experiment observed in the M-GR-L case are evidence for this conclusion. The children from the M-GR-L and M-GR-M cases have access to Montessori size and numeration materials, such as golden beads, numerical rod, pink tower, brown stairs, and cylinder blocks, which are considered to contribute to mathematical reasoning in the context of developing quantitative understanding. In addition, 3-D activity papers and materials to help improving both the numeration ability and the spatial ability are also available in both cases (Figure 90).

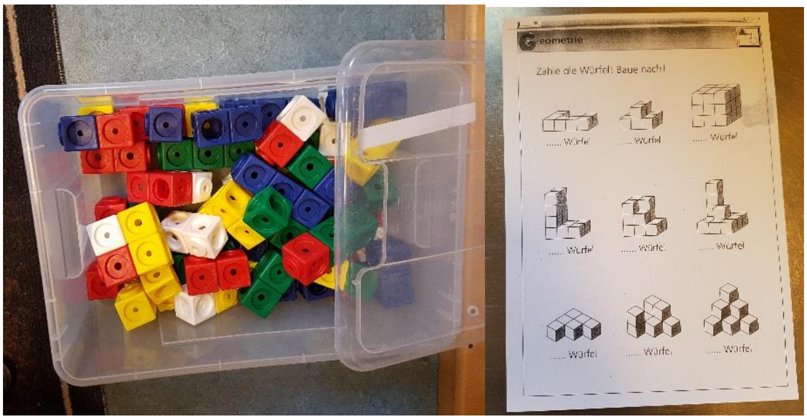

Figure 90. Picture of the 3-D activity materials used to improve mathematical reasoning

In the M-GR-M case, one child was at Level 2, seven children were at Level 3, and one child (Lukas) performed at Level 4. This boy explained in relation to the water hole story that water came from the ocean, and at the end of story, all the animals swam to the ocean; there was a whale here, and some of these animals were eaten by the whale. Interestingly, all children from M-GR-L performed at Level 3 in dynamic thinking.

4.3.5.3.2 One-Way Causality

In this aspect of systems thinking, the aim was to assess the connections that children made in the story about water considering whether they detected the domino causality and multiple causality, as well as the direct and indirect connections. The way the children perform in dynamic thinking aspect is similar to the one-way causality aspect of systems thinking. In the M-GR-M case, one child was at Level 2, seven children were at Level 3, and one child performed at Level 4. Two of the children from M-GR-L performed at Level 2 and 12 children performed at Level 3.

In the M-GR-M case, there were many different types of conversations that support the one-way causality aspect of the systems thinking were witnessed. Moreover, those one-way causality conversations observed in this case were the most sophisticated compared with other cases. Also, those conversations had the potential to provide children with the foundation for developing an understanding system mechanisms aspect of the systems thinking. There were two examples of clear one-way causality evidence in the volcano experiment. One was when the teacher explained the working principle of the dropper when the child was trying it, “before the dripper is squeezed, there is air in it. When we squeeze it, the air goes out and water goes in”. Second was when the teacher presented the information about the lava coming out from the volcano: “The layers of the earth with rock-earth on it are broken by the movements of the continents; then, the hot lava flows out of the depths of the earth”.

During the period of observation in the M-GR-L case, as presented previously in the jelly sweets experiment, most of the questions posed by the teacher can be associated with one-way causality dimension, such as why Emre cannot eat this jelly sweet, why this jelly sweet does not stick, and why the they grew bigger. In conclusion, it can be stated that children from both cases were engaged in one-way causality experiences and the indicator referring to this skill was fully fulfilled.

4.3.5.3.3 Feedback Thinking

As explained above, the children from the M-GR preschool have a strong linear causality background. In the feedback thinking aspect of systems thinking, the aim was to measure the children’s ability to detect the behaviors in the system that can feedback on each other to form positive and negative processes. The indicator referring to the engagement of the children in closed-loop thinking practices was not fulfilled in the M-GR-L case and the M-GR-M case. However, it should be remembered that the children were carrying out activities to observe the cyclic movements of nature with the second teacher assigned to the M-GR-L case. Given the feedback loop in the story, evidence corresponding to statement patterns like ‘the more, the more’, ‘the less, the less’, ‘the more, the less’, and ‘the less, the more’ was sought in the field work, but no such evidence was clearly found in either of the cases.

There was no child that performed at Level 1 in both cases. In the M-GR-M case, five children closed the loop by not specifying quantities (Level 2), and three specified the quantity while closing the loop (Level 3). There was only one child who was able to recognize multiple-closed loops and performed at Level 4. One of the two children that performed at Level 4 called Paula was a member of the M-GR-M case. According to this young girl, if people were part of the story, they would have to catch some of the animals, because it would be impossible for people to have enough water when there were so many animals in the story. In the M-GR-L case, one child closed the loop by not specifying quantities (Level 2), and 13 specified the quantity while closing the loop (Level 3).

4.3.5.3.4 Big Picture Thinking

This aspect focused on measuring the children's ability to demonstrate a multi-perspective approach and comprehend a given issue from a more holistic perspective by responding to questions, such as ‘What was this story about?’ and ‘What could the title of the book be?’. It was found that the M-GR preschool has a sensitive approach to reading books:

> We allocate a significant amount of the budget to book purchase, ensure that books are rotated in different classes, and tell children and their families that they can bring developmentally appropriate books to the preschool whenever they want. We have a lot of books to help children develop expertise in different subjects, and these books make our project work much easier. From a very general calculation, I can say that the children in the learning groups you visited have read about 200 children's books through the year, and that these include specialist books (Administrator, M-GR).

It is, however, important to note that in observations, the adults did not ask questions, such as ‘What was this story about?’ and ‘What could the title of this book be?’ during the book reading activities. In the M-GR-M case, five children were at Level 2, and two children performed at Level 3. Two of the five children corresponding to Level 4 who provided two multi-dimensional responses to both questions and displayed a relatively more holistic approach to the issues belong to the M-GR-M case. For example, according to Gustav, the story was about animals wanting to drink water but not being able to do this; so, the title of the book could be “The Drought” and Nora thought that the story was about too many animals wanting to drink from the water hole; thus, the title of the book could be “The Jungle”. In the M-GR-L case, five children performed at Level 2 and nine children performed at Level 3.

4.3.5.3.5 Understanding System Mechanisms

For this aspect, the aim was to determine the children's understanding of system mechanisms by adding a new component to the system. In the M-GR-M case, two children stated that there would be no change in the system and were categorized as being at Level 1. Two children described only the potential local and short-term impacts of adding the new component to the system. Five children described the wider and long-term potential impacts of adding the new component to the system. There was no child who considered the possibility of unexpected changes in the system.

In the M-GR-L case, one child stated that there would be no change in the system and was categorized as at Level 1. Seven children described only the potential local and short-term impacts of the addition of adding the new component to the system. Five children described the wider and long-term potential impacts of adding the new component to the system. When all child participants are considered, one member of the M-GR-L case, Luka, responded to this aspect at Level 4, and considered unexpected changes in the system.

> Investigator: ... Well, what would happen if there were people in the story?
> Luka: The amount of the water would decrease.
> Investigator: Then, what would happen?
> Luka: There would be one less tree in the forest because trees also need water.

Tools that can help to give high-level answers to this type of question include exercises, such as talking about a system in detail or asking 'what happens if we remove this component or add this component' when undertaking causality practices. As mentioned previously, the teacher in the M-GR-M case presented the children with explanations at a phenomenological level. The teacher engaged in conversations related to the working mechanisms of different things, such as why lava flows out of the volcano, how matches are made, what the working principle of the dropper is, and how the cactus rain stick is made. However, it was concluded that these examples do not offer children a deep experience on how systems work in their entirety. In this respect, it was concluded that the M-GR-M case partially fulfilled the indicator concerning 'there are conversations about how systems work'. In the M-GR-L case, it was concluded that detailed activities about natural systems were conducted, and that there are some conversations about how natural systems work in this case. In the classroom of the M-GR-L case, there were many posters and worksheets about different natural systems, and the teachers explained that they use those materials very often; however, in both cases, the indicator referring to 'adults and children discuss what would happen if a component was added to or removed from the system' was not fulfilled.

4.3.5.3.6 Problem-Solving

The children's problem-solving ability in a given problematic system behavior was determined in this aspect of systems thinking. In the M-GR-M case, in the framework of the problem-solving question that the children were asked, one child's answer was evaluated at Level 1, one at Level 2, four at Level 3, and three at Level 4. Paula, Gustav and Luca are the children who provided responses at Level 4 and their solution suggestions are presented below:

"Water can be given to everyone, water can be shared" (Paula, M-GR-M). At the same time, this child revealed a delay awareness in a different part of the interview.

“We can share water, but if it is finished again, we can get water from elsewhere” (Gustav, M-GR-M). Like Paula, Gustav also revealed delay awareness in a different part of the interview.

“Before the water was completely consumed, I would gather all animals together and together we would discuss who could help us” (Luca, M-GR-M).

In the M-GR-L case, one child’s answer was evaluated at Level 1, five at Level 2, and eight at Level 3. No child performed at Level 4 in this case.

In the context of problem solving, the conclusion was that the children had some experience in both of the educational contexts. For example, in the M-GR-M case, the teacher gave the materials to the two girls who wanted to make a cactus rain stick, and then left them alone to engage in the activity. Children had to work out how to construct this instrument by themselves. One of the children mistakenly spilt a container of paint when working on a watercolor in the M-GR-L case. The teacher did not get involved in this situation. The child calmly went to the toilet and got a clean cloth and an empty cleaning bucket to clean up the spilt paint. However, the children attending the M-GR preschool do not lack adult supervision as was the case with the children at the A-GR preschool. In this regard, the indicators referring to 'children were let to encounter real-life problems' and 'adults provided opportunities for children to solve their problems' were partially fulfilled in both cases.

4.3.5.3.7 Hidden Dimension

In this dimension, the aim was to assess the children's ability to detect obvious and hidden components and processes in the system. In this aspect, it was concluded that children from the M-GR-M and M-GR-L cases performed better than the other cases. In the M-GR-M case, three of the children's answers were evaluated at Level 2, two at Level 3, and four at Level 4. The M-GR-M case is in a special position, especially in terms of the number of children that responded at Level 4. According to Louisa (M-GR-M), the water in the story decreased as it both went to the stomach of the animals and the sun rose and dried the water. Flowers, people, and soil need water other than animals. Water is needed for people and earth to breathe.

In the M-GR-L case, the answers of the children were evaluated as at Level 1, and the remaining children were evaluated as follows; four at Level 2, eight at Level 3, and one at Level 4.

Since the hidden dimension aspect is related to the root-causes thinking skill and subject matter knowledge, there are two issues to be considered. One of the possible areas that supports the hidden component is the discussion of the root causes. Conversations that are sufficiently deep to focus on root causes when constructing cause and effect associations were not found in either case; however, it should be noted that deep project learning opportunities were experienced and more qualified causal relations were established in both cases compared to the other cases. As a result, the indicator referring to 'there are conversations about root causes' were partially fulfilled in the M-GR-M and M-GR-L cases. Both cases did not fulfill the indicator referring to ‘there are conversations about hidden components and processes in systems’.

Subject-matter knowledge was very important in both cases; so, this indicator was fully fulfilled[41]. The preschool administrator's comment on the specialist books they obtained to develop subject matter knowledge is considered as evidence for this issue. In addition, it was observed that children in both cases were engaged in deep project work in which their subject-matter competencies were substantially developed. The last evidence in this context is the emphasis on learning goals in 'subject-matter competency' under the title *Sachkompetenz* in the Berlin ECE curriculum. Children's having some prior knowledge of the water cycle is a factor which makes it easy to comment on hidden components and processes. Deducing from the conversations with the teachers, it was concluded that the children had not had any previous educational experience of discussing the water cycle, population, and animal migration in the M-GR preschool.

Finally, in both learning contexts, children were generally seen to perform imaginative activities in their free playtime. In the M-GR-L case, the children were often asked future prediction questions, and an opportunity for imagination was created through future prediction exercises. In the M-GR-M case, it was concluded that children had an even more rich experience in the context of imagination. The evidence in support of this inference is

[41] It was deduced from the conversations with the teachers that the children did not have any previous educational experience of discussing the water cycle, population, and animal migration in either of the cases.

the activity in which the children listened to recorded sounds. Given the experience in the other cases, M-GR-M was the most competent in terms of the indicator referring to 'children were engaged in imagination practices', and it was concluded that this case fully fulfilled this indicator.

4.3.5.3.8 Time Dimension

For the last dimension in systems thinking, the aim was to detect the children's ability to comprehend time and make a future prediction. In order to collect data in this area, an assessment was made concerning whether the future prediction work was undertaken with the children in the field and if there were conversations about future prediction, past-present-future connection, and about time in general. In both cases, the children were clearly not engaged in conversations related to time, as the work in this context was implicitly done, and it was concluded that this indicator was partially fulfilled. Considering that both cases engage in long-term project work, and back-and-forth practices in terms of time and space were undertaken within the same subject, and especially when compared to other cases, it was concluded that the indicator referring to ‘children become involved in conversation related to past-present-future connection’ was only partially fulfilled. Again, in both cases, many questions and conversations related to future prediction were observed, and it was concluded that the indicator related to future prediction practices was fully fulfilled in both cases located in the M-GR preschool.

The performance of the children in both cases in the time dimension aspect is similar. In the M-GR-M case, two of the children's future prediction skills were at Level 1, five at Level 2, and two at Level 3. In the M-GR-L case, three of the children's future prediction skills were at Level 1, eight at Level 2, and three at Level 3. In this aspect, the number of children with the highest number of answers at Level 3 was from the M-GR-L case.

4.4 Cross Case Analysis Findings

In this part of the thesis, cross-case analysis results of the educational contexts and the child participants' systems thinking skills that are present in these contexts are presented**.** Accordingly, similarities and differences between mainstream and alternative education cases from Turkey vs. mainstream and alternative education cases from Germany; mainstream education case from Turkey vs. mainstream education cases from Germany; and alternative education case from Turkey vs. alternative education case from Germany are demonstrated. As Sandelowski (1996) pointed out, “looking at and through each case in a qualitative project is the basis” of analytic interpretations and generalizations (p. 525). One of the main aims of this multiple case study was to create an understanding regarding the differences and the similarities between the cases (Baxter & Jack, 2008; Stake, 1995). Yin (2003) explained that a multiple case study enables the researcher to analyze the data within each situation and also across different situations, unlike when a single case study is chosen. In that sense, in this part of the research report, firstly, the participants' profiles is articulated on the basis of countries in which the preschools are located, and comparisons will be made. Secondly, the systems thinking skills of the child participants are presented across the cases. Thirdly, the systems skills of the children are compared and contrasted within the cases. Fourthly, the characteristics of the educational contexts are compared and contrasted across and within the cases. Lastly, the combination of the characteristics of the participants, systems thinking characteristics of the cases and the characteristics of the educational context are presented to understand the effect of Turkish and German educational contexts on the systems thinking skills of 4- to 6-year-old preschool children.

4.4.1 Sample Characteristics Across Countries

As shown in Table 38, the gender distribution of the 21 children participating in the study from Turkey was dominated by girls. The mean age of the child participants from Turkey was calculated as 58 months with only one child being bilingual. Regarding the parent education level, 21 Turkish participants (95.2%) had at least one parent that received university education, and for only one child, neither parent had an undergraduate degree. The mean ECE enrolment age for the Turkish children was 35 months old.

Table 38. Profile of the child participants from Turkey and Germany

		TURKEY (N = 21)		**GERMANY (N = 31)**	
	Characteristics	**Frequency**	**%**	**Frequency**	**%**
Gender	Girls	12	57.1%	16	51.6%
	Boys	9	42.9%	15	48.4%
Age	48-59 months old	12	57.1%	5	16.1%
	60-71 months old	9	42.9%	18	58.1%
	72+ months old	0	0%	8	25.8%
Bilingual	Yes	1	4.8%	11	35.5%
	No	20	95.2%	20	64.5%
Education Level of One of the Parents	University degree or above	20	95.2%	21	67.7%
	Less than university degree	1	4.8%	10	32.3%
Mean ECE Enrolment Age		35 months old		23 months old	
Mean Age		58 months old		65 months old	

The gender distribution of the 31 participants from the German educational contexts was balanced. The mean age of these child participants was 65 months. Unlike the child participants in Turkey, one-third of the participants from Germany were bilingual and at least one of the parents of the 21 children had a university degree (67.7%) The mean ECE enrolment age was 23 months.

As shown in Figure 91, the age distribution of the children from Turkey was as follows: 12 children (57.1%) 48 to 59 months old and 9 were aged 60 to 71 months (42.9%). There were no children in the 72+ months category. The age distribution of the children from Germany was as follows: five children (16.1%) were aged 48 to 59 months, 18 were (58.1%) 60 to 71 months old, and eight (25.8%) were 72 months or older.

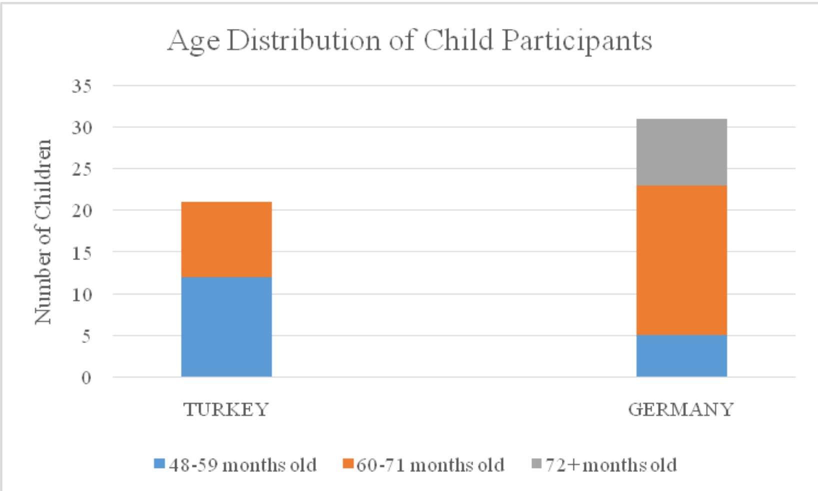

Figure 91. Age distribution of child participants from Turkey and Germany

Information about the adult participants' profiles is provided in Table 39. One of the adult participants from Turkey was male and the others were female. All of the adult participants from Germany were female. All the adult participants from Germany had received the vocational school education called *Fachabschluss*. Sixty percent of the adult participants from Turkey were four-year university graduates, and the remaining 40% were graduates of vocational high schools called *Meslek Lisesi*. The average age of the participants in Turkey was 40.6 years old. They had been teachers for 19.2 years on average, and had been working in the target preschool for 9.4 years on average. The mean age of the adult participants from Germany was 53.8 years. On average, they had 30.3 years of teaching experience and had been working at the target preschool for an average of 11 years.

Table 39. Profile of the adult participants

		TURKEY (N = 5)		GERMANY (N = 6)	
	Characteristic	**Frequency**	**%**	**Frequency**	**%**
Gender	Female	4	80%	6	100%
	Male	1	20%	0	0%
Educational Background	Vocational training	2	40%	6	100%
	University	3	60%	0	0%
Average professional experience (year-based)		19.2 years		30.3 years	
How many years s/he working in the preschool (average)		9.4 years		11 years	
Mean age		40.6 years old		53.8 years old	

N = 11

Conclusions about the child and adult participants across countries:

- ECE teachers and administrators in cases from Germany were older and more experienced in the field, their pre-service education levels were very similar. ECE teachers and administrators in the cases from Turkey were younger and less experienced in the field, and their levels of pre-service education differed from their peers.
- Children attending preschools in Germany were older on average.
- On average, children belonging to cases in Turkey started ECE one year later than the children belonging to cases in Germany.
- Parents of the children from Turkey had higher levels of education.
- There were bilingual and multicultural children in the educational contexts in Germany, whereas almost all of the children in the educational contexts in Turkey were monolingual and monocultural.

4.4.2 Systems Thinking Skills of Children Across Cases

In this part of the findings chapter, case-based distributions of the results obtained from the rubric are presented. The main objective of this analysis was to reveal the common and uncommon characteristics of the child participants on a comparative basis. The findings related to the eight aspects in the rubric are presented in graphs. It should be noted that the number of children participating in the interview differed in each case, and Table 40 details the number of participants in each case.

Table 40. Distribution of child participants across cases

Name of the Case	Number of Child Participants
A-TR (Alternative education case from Turkey)	9
M-TR (Mainstream education case from Turkey)	12
A-GR (Alternative education case from Germany)	8
M-GR-M (Mainstream education case from Germany with higher educated parents)	9
M-GR-L (Mainstream education case from Germany with lower educated parents)	14

N=52

4.4.2.1 Dynamic Thinking

In terms of the dynamic thinking levels of children on a case basis (Figure 92), it was concluded that except for the M-TR case, the child participants generally performed at Level 3 (they were able to trace the dynamic behavior noticing that there was a gradual change when a gradual time-perspective was given). The M-GR-L case was special in this aspect because all the participant children provided interview responses within Level 3. Level 4 responses were given by children belonging to the A-TR, M-GR-M and A-GR cases. Those children were able detect a circular dynamic behavior pattern through a much longer time-view and incorporated both obvious and hidden components and processes. There was one child at Level 1, who belonged to the M-TR case. The child did not notice any change in system components.

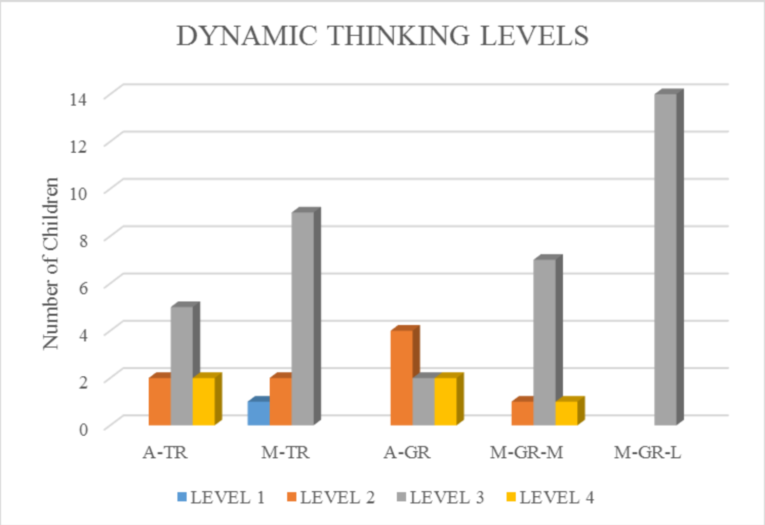

Figure 92. Dynamic thinking levels across the cases

4.4.2.2 One-Way Causality

As shown in Figure 93, when one-way causality aspect was considered, there was no participant in Level 1; thus, all the children could build some sort of a linear cause-and-effect relationship. In the M-GR-L case, a situation similar to the dynamic thinking aspect was observed. The children in this case mostly (12 participants) performed at Level 3 (described two-step linear connections that result in direct and indirect effects or mentioned multiple causes and/or multiple effects), and the responses of the remaining children from that case were scored at Level 2 since they built a one-way relationship between one cause and one effect. In the A-TR and M-GR-M cases, the concentration of responses at Level 3 was observed and one child performed at Level 4. This child described an extended linear pattern that included a multi-step linear connection of three or more steps with indirect effects. There were no participants that gave responses at level 4 in the A-TR, A-GR and M-GR-L cases. Half of the participants in the M-TR case gave responses at Level 2; two children performed at Level 3, and one child performed at Level 4. In the A-GR case, three participants performed at Level 2, and five at Level 3.

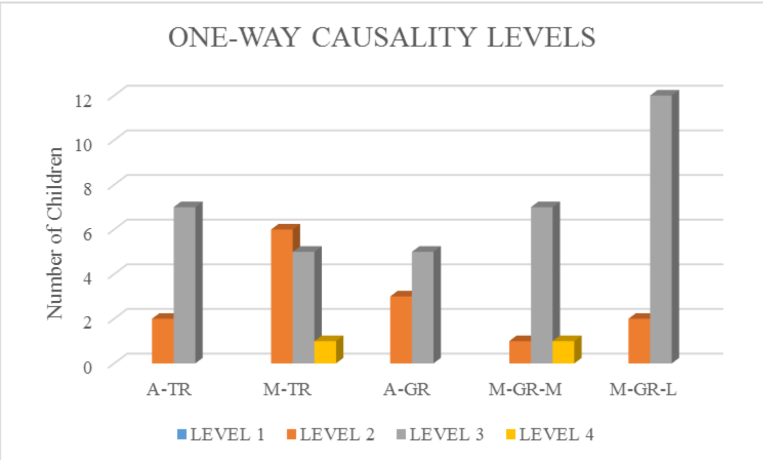

Figure 93. One-way causality levels across the cases

4.4.2.3 Feedback Thinking

The results of the child participant's feedback thinking levels across the cases are displayed in Figure 94 showing that one child that performed at Level 1 belonged to the A-TR case, three children to the M-TR case, and two children to the A-GR case. Those children were only able to notice one-way linear connections, and they were not aware of the reciprocal connection between components. One of the two participants who performed at Level 4 belonged to the M-GR-M case and the other to the A-GR case. Those children described the behavior of a balancing and a reinforcing loop. The M-GR-L case participants mostly performed at Level 3, as in the dynamic thinking and one-way causality aspects. It was observed that the distribution in the A-TR, M-TR and M-GR-M cases was mostly seen at Level 2 (closed the loop by describing the mutual relationship between components, but did not describe the behavior of this feedback structure over time) and Level 3 (closed the loop, described the behavior of the feedback loop). However, in A-GR, there were participants who gave responses at all levels.

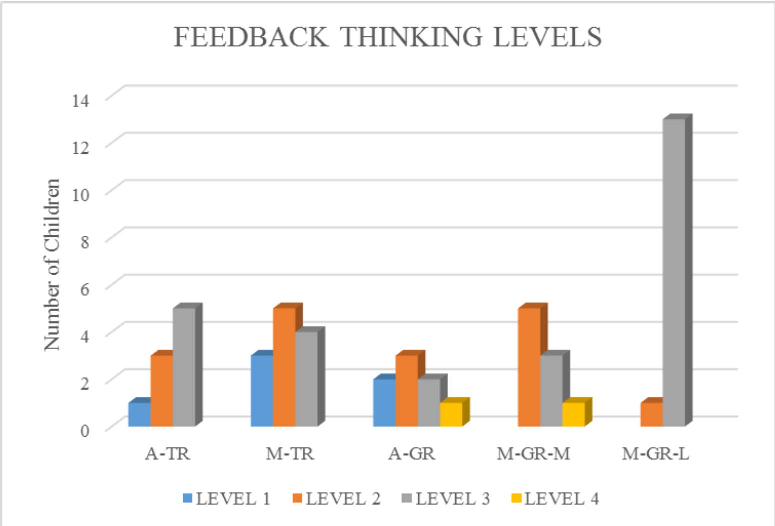

Figure 94. Feedback thinking levels across the cases

4.4.2.4 Big Picture Thinking

The case-based distributions of child participants according to the big picture thinking aspect are shown in Figure 95. Participants that remained at Level 1 belonged to the M-TR (n=1) and A-GR (n=2) cases. Those children did not provide responses to big picture thinking questions. The responses given at Level 4 were from the A-TR, M-TR and M-GR-M cases. Those children provided two multi-dimensional responses to both of the questions and displayed a relatively more holistic approach to the issues. In the M-GR-L case, a similar stacking was observed in the previous aspects, with 13 of the children in this case having Level 2 performance (demonstrated uni-dimensional perspective) and one having Level 3 performance (demonstrated partial multi-dimensional perspective). The level distributions of the A-TR and M-TR cases were similar with more participants being at Levels 2 and 3. Approximately half of the participants in the M-GR-M case performed at Level 2, two children performed at Level 3, and a further two performed at Level 4. In A-GR, half the respondents gave Level 3 responses, with two children's responses belonging to Level 1 and two children's responses belonging to Level 2.

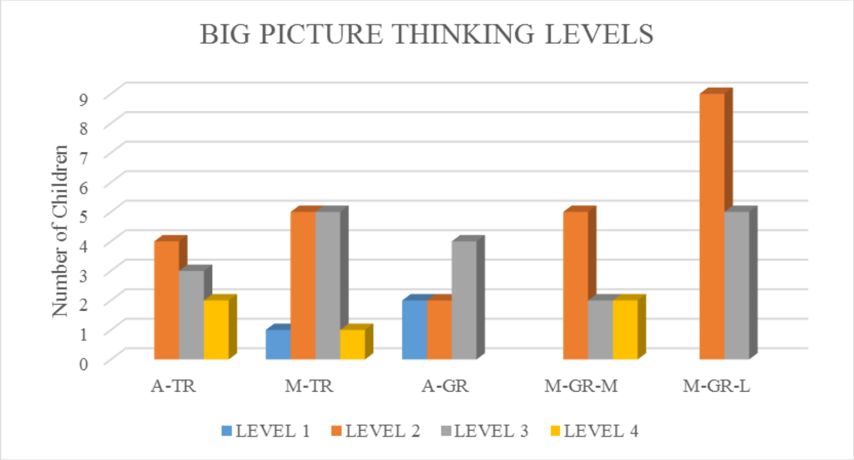

Figure 95. Big picture thinking levels across the cases

4.4.2.5 Understanding System Mechanisms

The results of the understanding systems mechanisms aspect are presented in Figure 96. The only child who performed at Level 4 was a member of the M-GR-L case. This child considered the possibility of unexpected changes in the system, if a new component was to be added to the system. The number of children that performed at Level 1 in the A-TR, M-GR-L and M-GR-M cases was the lowest when compared to the number of participants in each case. Those children described that there would be no change in the system, if a new component was to be added to the system. In the A-TR, M-TR and M-GR-L cases, most of the children's responses belong to Level 2. For those who performed at Level 2, the children only described the potential local and short-term impacts of the addition of the new component to the system. In the M-GR-M case, the concentration of the children's responses appeared at Level 3. Those children described wider and long-term potential impacts of adding the new component to the system.

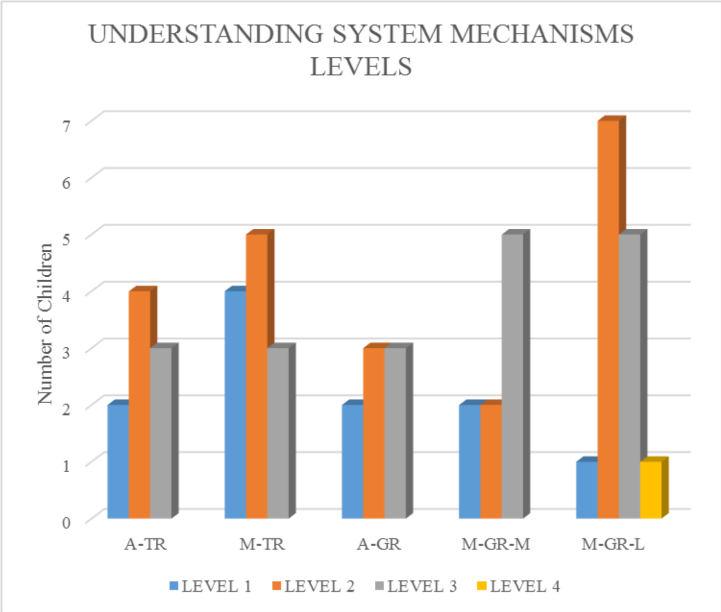

Figure 96. Understanding system mechanisms levels across the cases

4.4.2.6 Problem Solving

As illustrated in Figure 97 in relation to the problem solving aspect, there were child participants performing at all levels in all the cases except the M-GR-L case, in which no participant performed at Level 4. Approximately half of the respondents from the M-GR-L and M-GR-M cases provided responses at Level 3 by adopting a quick-fix approach to the problem, such as increasing the amount of water or reducing or suspending water consumption. However, they were not aware that those solutions would create new problems. In all cases, except M-GR-M, stacking was at Levels 1, 2 and 3, while in the M-GR-M case, it was at Levels 2, 3 and 4. The highest number of responses at Level 4 once again belonged to the M-GR-M case. Those children demonstrated a longer term diagnostic approach by focusing on possible root causes or offering more sophisticated intervention points, such as acting in time before the water has fully dried up (being aware of the delay in the system) or distributing the resource fairly.

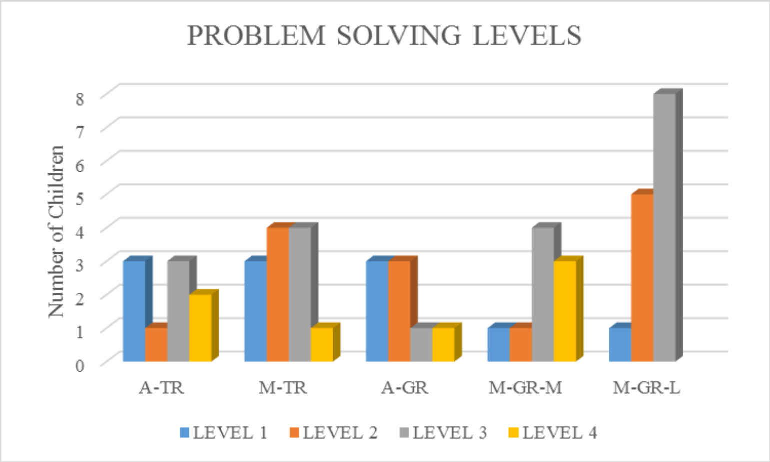

Figure 97. Problem-solving levels across the cases

4.4.2.7 Hidden Dimension

Considering the hidden dimension levels across the cases in Figure 98, no child participant remained at Level 1 in the A-TR and M-GR-M cases. Stacking was observed at Level 2 in A-TR and M-TR cases, those children identified up to two hidden components. In the M-GR-L case, stacking was noticeably seen at Level 3, children at this level identified more than two hidden components. The most frequent Level 4 responses were provided by four children belonging to the M-GR-M case, in addition to hidden components, those children described hidden processes. In the A-GR case, three children gave Level 1 (by mentioning only about obvious components and processes) and Level 2 responses, and two children provided Level 4 answers. No response at Level 3 was found in this case.

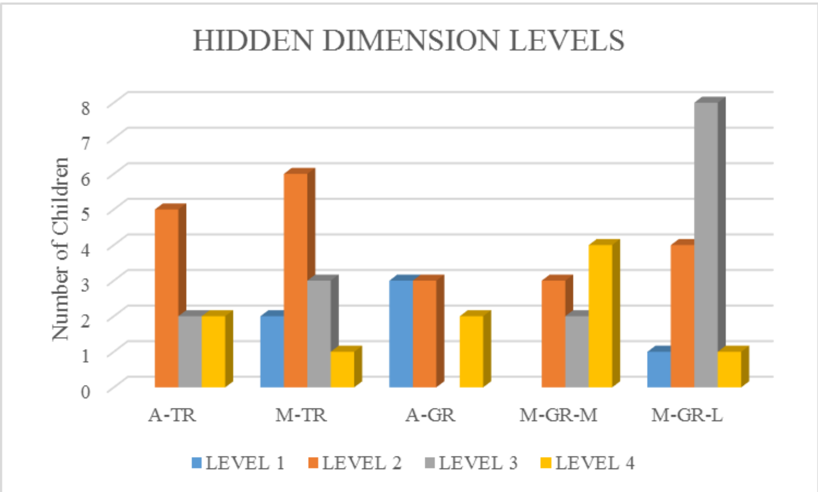

Figure 98. Hidden dimension levels across the cases

4.4.2.8 Time Dimension-Future Prediction

None of the children were able perform at Level 4 in the time dimension-future prediction aspect of systems thinking (Figure 99). Thus, the children were unable to grasp the extent of the sophistication of the dynamics of even a simple system; so, they did not try to foresee how it would act. All of the cases except the M-TR case had children who responded at Level 3. Children who performed at Level 3 made future predictions through seeing the issue from a wider perspective; they positioned prediction in a larger time interval and made predictions not only based on the existing pattern. The highest number of responses at Level 3 belonged to the M-GR-L case. Stacking in the A-TR and M-TR cases was seen at Levels 1 and l 2. Children who performed at Level 1 did not provide valid responses to future prediction question. Children who performed at Level 2 constructed their future predictions on the existing pattern. In the M-GR-L, M-GR-M and A-GR cases, stacking was observed at Level 2.

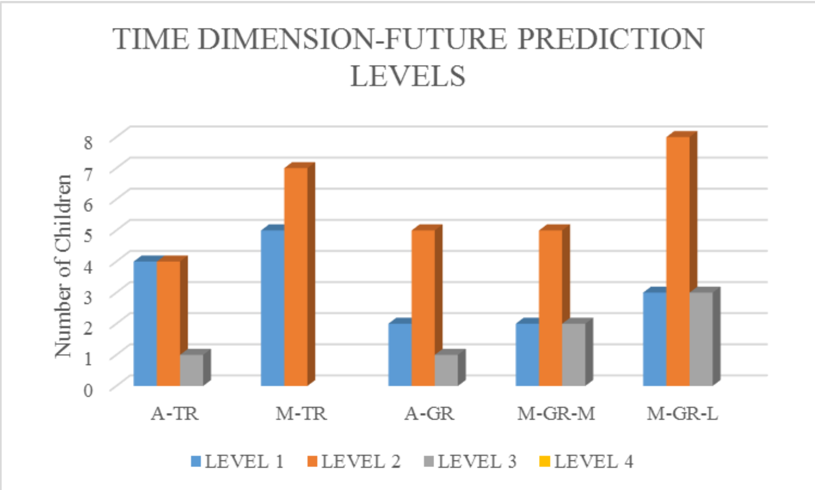

Figure 99. Time dimension levels across the cases

4.4.3 Systems Thinking Skills of Children Within Cases

This section presents an assessment of the systems thinking skills of children via within-cases-approach based on the overall performance of each case in all aspects. In this context, children's systems thinking skill scores were calculated on case basis, and general profile of the child participants is presented in Table 41.

In the first part of the findings chapter, the age of the children was found to have an effect on scores. Therefore, the averages of the ages and the scores of the children of the same case were calculated and the standard deviation calculation was obtained for these variables. As a result, the highest mean score was 13.44 points with a 4.15 standard deviation belong to the M-GR-M case. The M-GR-L case ranked the second with a 12.71 mean score and 2.09 standard deviation. The third was the A-TR case with a means score of 12 points and 4.63 standard deviation. After this stage, a dramatic decline was observed in the mean scores. The mean score of the A-GR case was 10.13, and the standard deviation of the scores was 5.66. The mean score of the M-TR case, the last in the rank, was 9.83, and the standard deviation of the scores was 7.28.

On average, the children belonging to the M-GR preschool cases were almost one year older than the child participants in the other cases. It was concluded that the most homogeneous group of children according the age distribution of the cases was the M-GR-M case with a 3.65 standard deviation, and the second homogenous group was the M-GR-L case with a 5.31 standard deviation. The age distributions were more diversified in the other cases, with the standard deviations ranging from 6.02 to 7.68. Table 41 also presents information concerning the children's language and family backgrounds.

Table 41. Systems thinking scores of children on a case basis

<table>
<tr>
<td><u>A-TR Case</u>
Mean Age: 59 months
Standard Deviation of Ages: 6.02
Mean of Scores: 12
Standard Deviation of Scores: 4.63
Almost all one of the parents of the children were university educated (88.9%)
All monolingual children</td>
<td colspan="2"><u>A-GR Case</u>
Mean Age: 58 months
Standard Deviation of Ages: 7.68
Mean of Scores: 10.13
Standard Deviation of Scores: 5.66
All one of the parents of chi children were university educated
Half monolingual, half bilingual children</td>
</tr>
<tr>
<td><u>M-TR Case</u>
Mean Age: 57 months
Standard Deviation of Ages: 7.28
Mean of Scores: 9.83
Standard Deviation of Scores: 4.08
All one of the parents of the children were university educated
Almost all monolingual children (91.7%)</td>
<td><u>M-GR-M Case</u>
Mean Age: 67 months
Standard Deviation of Ages: 3.65
Mean of Scores: 13.44
Standard Deviation of Scores: 4.15
All one of the parents of the children were university educated
Almost all monolingual children (88.9%)</td>
<td><u>M-GR-L Case</u>
Mean Age: 67 months
Standard Deviation of Ages: 5.31
Mean of Scores: 12.71
Standard Deviation of Scores: 2.09
Mostly high school educated parents (71.4%)
Half monolingual, half bilingual children</td>
</tr>
</table>

4.4.3.1 Systems Thinking Skills of Children in Mainstream Educational Context from Turkey vs. Mainstream Educational Contexts[42] from Germany

When the systems thinking skills of children belonging to the mainstream educational contexts in Turkey and Germany were compared, it was concluded that the most profound difference exists in that the average scores of the children in the German preschools were higher than the children attending the target Turkish preschools. The standard deviation of the systems thinking scores of children belonging to the M-GR-L case was relatively lower, with the M-GR-M and M-TR cases having a relatively higher standard deviation of the systems thinking scores of children.

On average, children from the M-GR cases were 10 months older than those in the M-TR case. All the parents of the children belonging to the M-TR and M-GR-M cases had university degrees, whereas most of the parents of the children belonging to M-GR-L case had completed high school. Almost all the children belonging to M-TR and M-GR-M were monolingual, whereas half of the children belonging to the M-GR-L case were bilingual.

There was no clear pattern of the overall performance of child participants in the M-TR and M-GR-M cases. In the M-GR-L case, the participant levels in each aspect were stacked in the middle levels (Levels 2 and 3). In general, the participants of the M-TR case provided responses at Level 3 for dynamic thinking, and at Level 2 for one-way causality and feedback thinking aspects. Two of the Level 4 responses in one-way causality belonged to the M-TR case. In the M-GR-M case, although stacking was seen in Level 3 in the dynamic thinking and one-way causality aspects, Level 2 and Level 4 responses were also given. One of the two Level 4 responses on one-way causality aspect was provided by a child belonging to the M-GR-M case. In the feedback thinking aspect, most of the answers remained at Level 2. The participants from the M-GR-L case mostly performed at Level 3 for dynamic thinking, one-way causality, and feedback thinking.

In the M-TR case, in the big picture thinking, problem solving and hidden dimension aspects, there were responses at every level. In the big picture thinking aspect, one of the five responses evaluated at Level 4 belonged to this case. The number of participants from M-TR responding at Levels 1, 2 and 3 were similarly distributed across the aspect of

[42] There were two mainstream cases from Germany.

understanding systems mechanisms. In the time dimension-future prediction aspect, it was observed that the participants' skills were distributed among Levels 1 and 2, there was no Level 3 response unlike the other cases. In the M-GR-M case, in the big picture thinking aspect, there were no children who responded at Level 1, with the children generally providing Level 2 responses. In the M-GR-M case, the children were more advanced in the aspects of understanding system mechanisms, problem solving, and hidden dimension when compared to other cases. In the time dimension-future prediction aspect for this case, there was a concentration on Level 2 like other cases. The participants' skill levels from the M-GR-L case were generally concentrated at Level 2 in the aspects of big picture thinking, understanding system mechanisms and time dimension-future prediction. The most advanced answer recorded in the understanding system mechanisms aspect was found in this case.

4.4.3.2 Systems Thinking Skills of Children in the Alternative Educational Context in Turkey Compared with Children in the Alternative Educational Context from Germany

As presented in Table 41, from the comparison of the children's systems thinking skills in alternative educational context in Turkey and Germany it was concluded that the average scores of the children in the Turkish cases were higher than those of the children in the German cases. The standard deviation of the systems thinking scores of children belonging to both of the alternative education cases were similar. The mean age of the children from both alternative education cases was also similar; however, the standard deviation of the ages of children belonging to the A-GR case were higher. All the parents of the children belonging to A-GR and almost all the parents of the children belonging to the A-TR case had university degrees. All the children belonging to the A-TR case were monolingual, whereas half of the children belonging to the A-GR case were bilingual.

The overall performance of child participants in the A-TR and A-GR cases did not have a clear pattern. In the A-TR case, in the aspects of dynamic thinking, one-way causality, and feedback thinking, the children's skill levels were often stacked at Level 3. Some of the small number of advanced level responses in the dynamic thinking and feedback thinking aspects were provided by the children belonging to the A-GR case. The children’s skill levels in one-way causality were often stacked at Level 2.

In A-TR, in the big picture thinking aspect, the children performed at Levels 2, 3 and 4, whereas in M-GR, the children performed at Levels 1, 2 and 3. In the understanding system mechanisms aspect, which can be evaluated as a relatively more complicated skill, the responses of the participants of the A-TR case and the A-GR case were distributed among Levels 1, 2 and 3.

In the problem-solving aspect, children belonging to the A-TR case performed better, with most of the responses being stacked at Levels 3 and 4, whereas most of the responses came from the A-GR case were stacked at Levels 1 and 2. The participants of the A-TR case gave relatively more advanced answers in the hidden dimension aspect. In the time dimension-future prediction aspect, the responses of the participants from A-TR were at a relatively low level, with a substantial part of the answers being at Levels 1 and 2. In the A-GR case, a substantial number of the answers were at Level 2.

4.4.4 Educational Contexts Across Cases

In this part of the findings chapter, case-based distributions of the results obtained from the Sustainability and Systems Thinking Indicators Checklist are presented. The main objective of this analysis was to reveal the common and non-common characteristics of the educational contexts on a comparative basis. The findings related to the six aspects in the indicator checklist are presented in graph format.

4.4.4.1 Preschool Climate

Six indicators are discussed pertaining to this aspect and the extent to which the indicators were fulfilled is presented in Table 42 and Figure 100.

As shown in Table 42 and Figure 100, the M-GR-M and M-GR-L cases fulfilled all the indicators, which means M-GR was the preschool that best satisfied the indicators in terms of forming a participatory and communicatory environment, as well as providing professional development opportunities for teachers and opening up external spaces for experience and learning.

Table 42. Preschool climate across cases

1. Preschool Climate	M-TR	A-TR	A-GR	M-GR-M	M-GR-L
1.1 Opportunities for administrators, teachers and parents to have a say and be involved in all issues and themes that affect them are supported by institutionalized participation structures	N	P	F	F	F
1.2 Adults act out democratic forms of conflict resolution in preschool. Negotiation and conflict resolution processes are fostered	N	F	P	F	F
1.3 Children act out democratic forms of conflict resolution in the group. Negotiation and conflict resolution processes are fostered	N	F	N	F	F
1.4 Staff feedback and consultation sessions take place regularly	N	F	F	F	F
1.5 In the preschool, there is a comprehensive approach to staff development and training	P	F	P	F	F
1.6 The preschool works in close cooperation with individuals, organizations and authorities outside the school in order to open up external spaces for experience and learning	P	F	F	F	F

N: The indicator was not fulfilled
P: The indicator was partially fulfilled
F: The indicator was fully fulfilled

It was concluded that the second best case that satisfied the indicators overall was A-TR; however, there were inadequacies regarding family participation in this case. Following A-TR in the ranking was A-GR which was found to have no structural approach to conflict resolution and the professional development of teachers. M-TR fulfilled the indicators the least in terms of the preschool climate context. In this preschool, staff development and training, and opening up external spaces for experience learning indicators were only partially fulfilled and the other indicators were not fulfilled at all.

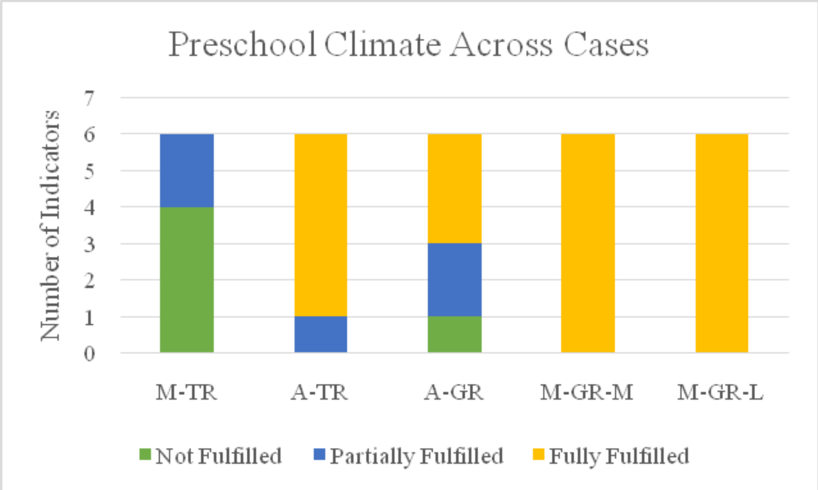

Figure 100. Preschool climate across cases

4.4.4.2 Physical Space

For this aspect, the extent to which the indicators were fulfilled is presented in Table 43 and Figure 101 followed by a discussion on the performance of the cases.

Table 43. Physical space across cases

2. Physical Space	**M-TR**	**A-TR**	**A-GR**	**M-GR-M**	**M-GR-L**
2.1 Children have access to most parts of the indoor environment	N	F	F	P	P
2.2 Children have access to most parts of the outdoor environment	N	F	F	F	F
2.3 There are abundant materials that children can use in many ways	N	F	P	F	F
2.4 Children have space to use the materials	N	F	F	F	F
2.5 Children have time to use the materials	N	F	F	F	F
2.6 Systems are illustrated in the learning environment	P	P	N	F	F
2.7 Children are able to see and touch the systems	N	P	N	N	F

N: The indicator was not fulfilled
P: The indicator was partially fulfilled
F: The indicator was fully fulfilled

As displayed in Table 43 and Figure 101, the M-GR-L case was better able to fulfill the indicators when compared with other cases. The children had access to most parts of the outdoor environment; there were abundant materials that children could use in many ways, and the children had the time and space to use those materials. Most importantly, children were exposed to living systems in their classroom, and they could interact with those systems. In the M-GR-L and M-GR-M cases, the children's opportunities to access to most parts of the indoor environment were relatively limited. M-GR-M was similar to M-GR-L in terms of indicators with the exception of 'children are able to see and touch the systems'. In this case, there was a lack of focus on systems which could provide opportunities for children to interact.

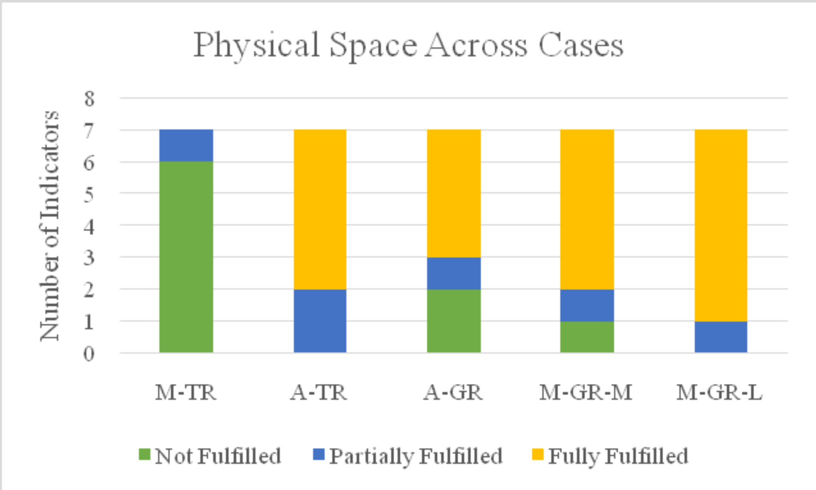

Figure 101. Physical space across cases

The A-TR case was in third place in terms of the indicators pertaining to the aspect of quality of physical space. This preschool had a real potential in the context of indicators regarding 'systems are illustrated in the learning environment' and 'children are able to see and touch the systems'. However, this potential was not completely enacted to achieve the realization of systems outcomes due to its fragmented educational structure.

The children belonging to the A-GR case were in the best position in terms of access to indoor and outdoor environment indicators due to the open concept utilized in the preschool. However, in this case, there were some shortcomings detected in terms of materials, but the children had time and space to use the existing materials. No data was found in terms of illustration of systems and interaction with systems in the A-TR case either. The M-TR case was last in the ranking in terms of the physical space indicators. There were some system posters in the M-TR classroom, and accordingly, the 'systems are illustrated in the learning environment' indicator was partially fulfilled, but the other indicators were not fulfilled.

4.4.4.3 Approach to Learning and Experiences

In this part of the report, the extent to which the indicators were fulfilled is presented in Table 44 and Figure 102 followed by a discussion of the cases.

Table 44. Approach to learning and experiences across cases

3. Approach to Learning and Experiences	**M-TR**	**A-TR**	**A-GR**	**M-GR-M**	**M-GR-L**
3.1 Learning experiences are linked with other learning experiences	F	F	N	F	F
3.2 Subject-spanning is utilized	F	F	N	F	F
3.3 Project-based learning is utilized	N	N	N	F	F
3.4 A multidisciplinary approach is utilized	F	F	F	F	F
3.5 An interdisciplinary approach is utilized	P	N	N	F	F
3.6 Documentation enables the children to observe their own learning processes throughout time	P	N	P	F	F

N: The indicator was not fulfilled
P: The indicator was partially fulfilled
F: The indicator was fully fulfilled

As displayed in Table 44 and Figure 102, it was deduced that the M-GR-M and M-GR-L cases implemented the most holistic learning and experience designs for the children. In these cases, learning experiences were linked to other learning experiences through deep project works. Both multidisciplinary and interdisciplinary approaches were utilized during the execution of the project-based learning. Also, documentation enabled the children to observe their own learning processes throughout time.

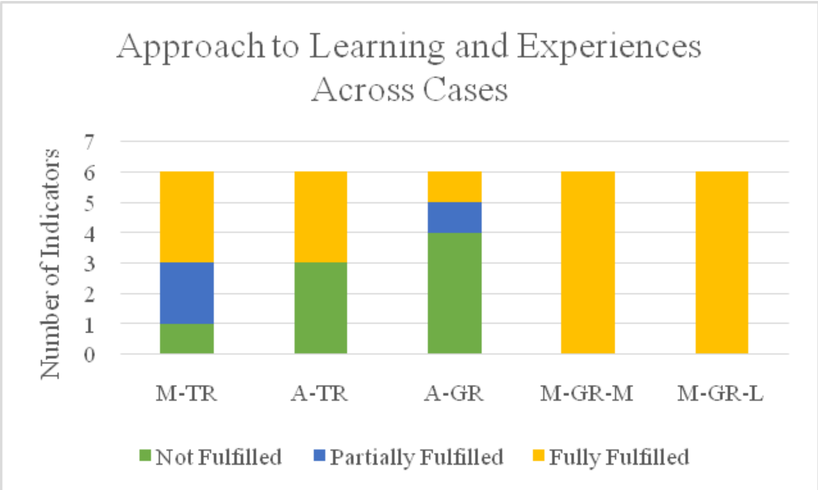

Figure 102. Approach to learning and experiences across cases

The M-TR case was the second best in fulfilling the indicators, and this was generally found to be similar in the M-TR and A-TR case. Learning experiences were partially linked with other learning experiences in both of the cases. Holistic and deep learning experiences, as observed in the M-GR cases, were not found in these cases. The activities undertaken in A-TR and M-TR mostly focused on certain subjects at certain times and certain intervals; in other words, subject-spanning, although in M-TR, an interdisciplinary approach was utilized and partially maintained. In A-TR, the children were exposed to different disciplines, but the transition between these disciplines was not provided due to the fragmentized workshop system.

In M-TR, the documentation partially allowed the children to observe their own learning processes over time; however, this indicator was not fulfilled in the A-TR case. The M-GR case lacked structure and content in terms of learning and experiences; however, a multidisciplinary approach was fully utilized, and documentation did partially enable the children to observe their own learning processes over time, but the other indicators are not fulfilled in this case.

4.4.4.4 Thinking and Acting Routines

There are 12 indicators discussed in this part of the report, and the extent to which the indicators were fulfilled is presented in Table 45 and Figure 103.

The case that best satisfied the indicators under this heading was M-GR-L, in which apart from the indicator, 'free play is extensively encouraged by adults' being partially fulfilled, the other indicators were fully fulfilled. The M-GR-L case has a teaching staff of good quality both in numbers and experience. This was followed by the M-GR-M case, which partially fulfilled two indicators; one related to free play, and the other being 'adults focus on individual children or creates small groups for deeper understanding'. The main reason for this situation is that the number of teaching staff assigned to this group was limited.

Table 45. Thinking and acting routines across cases

4. Thinking and Acting Routines	**M-TR**	**A-TR**	**A-GR**	**M-GR-M**	**M-GR-L**
4.1 Adults ask cognitively challenging questions	N	P	N	F	F
4.2 Children can talk freely	P	F	F	F	F
4.3 Children were let to ask questions	P	F	F	F	F
4.4 Adults create opportunities for a circle of viewpoints	P	F	N	F	F
4.5 Adults listen for and encourage children's thinking	P	F	P	F	F
4.6 Adults create open-ended experiences to foster creativity	N	P	P	F	F
4.7 Adults focus on individual children or creates small groups for deeper understanding	P	P	N	P	F
4.8 There are wrap-up or reflection exercises at the end of the activities	N	N	N	F	F
4.9 Adults display flexibility when creating learning opportunities	N	P	P	F	F
4.10 Adults provide children with the space to participate in decision-making processes in line with their age and abilities	N	P	N	F	F
4.11 Adults encourage children to do things for themselves	N	P	F	F	F
4.12 Free play is extensively encouraged by adults	N	P	F	P	P

N: The indicator was not fulfilled
P: The indicator was partially fulfilled
F: The indicator was fully fulfilled

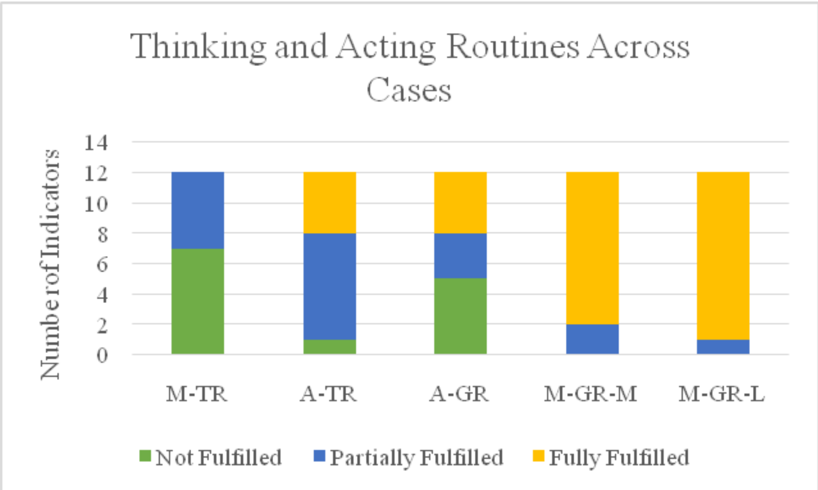

Figure 103. Thinking and acting routines across cases

The A-TR case ranked third in the findings in this group of indicators. In this case, children could talk freely and were allowed to ask questions, adults created opportunities for a circle of viewpoints, and adults listen for and encourage children's thinking. However, there was only a partial response by the adults in terms of asking cognitively challenging questions, creating open-ended experiences to foster creativity, focusing on individual children or created small groups for deeper understanding, displaying flexibility when creating learning opportunities, providing children with the space to participate in decision-making processes in line with their age and abilities, and encouraging children to do things for themselves. The indicator referring to 'free play is extensively encouraged by adults' was also only partially fulfilled in this case. There were no wrap-up or reflection exercises at the end of the activities in the A-TR case.

In fourth rank were the findings retrieved from the A-GR case, in which the children could talk freely and were allowed to ask questions. Furthermore, the adults encouraged children to do things for themselves, and free play was extensively encouraged. However, the adults only partially listened for and encouraged children's thinking, partially created open-ended experiences to foster creativity, and partially displayed flexibility when creating learning opportunities. In this learning environment, the adults did not ask cognitively challenging questions, did not create opportunities for a circle of viewpoints, did not focus on individual children or create small groups for deeper understanding, and did not provide children with the space to participate in decision-making processes in line with their age and abilities. There were no wrap-up or reflection exercises at the end of the activities.

The M-TR case did not fully fulfill any of the indicators in this section. Children could only partially talk freely and ask questions. The adults partially created opportunities for a circle of viewpoints, partially listened for and encouraged children's thinking, and partially focused on individual children or created small groups for deeper understanding. The other indicators were not fulfilled in this case.

4.4.4.5 Focus on Sustainability

There are nine indicators discussed below, and the extent to which the indicators were fulfilled is presented in Table 46 and Figure 104.

Table 46. Focus on sustainability across cases

5. Focus on Sustainability	**M-TR**	**A-TR**	**A-GR**	**M-GR-M**	**M-GR-L**
5.1 Theories and concepts of sustainability are used to reflect upon everyday knowledge and actions	N	F	N	P	P
5.2 Sustainability topics are integrated into internal preschool teaching curricula	N	F	N	P	P
5.3 Adults in the case received pre and/or in-service training in the field of ESD, EE and EfS	N	F	N	N	P
5.4 Purchasing policies for supplies, equipment and food are based in equal measure upon environmental and social sustainability and on economic viability	N	P	P	P	P
5.5 Resources are carefully managed by reducing, reusing and recycling	P	F	P	F	F
5.6 Adults provide the definition of the term "diversity" in a multi-dimensional way	N	F	F	F	F
5.7 Adults shows acceptance of people in their differences	N	F	F	F	F
5.8 Adults provide children with the opportunity to learn, appreciate and compare cultural diversity	N	P	F	F	F
5.9 Adults provide children with the opportunity to learn, appreciate and compare diversity in nature	P	F	P	P	F

N: The indicator was not fulfilled
P: The indicator was partially fulfilled
F: The indicator was fully fulfilled

When determining the fulfillment of sustainability indicators, although the A-TR and M-GR-L cases were very close to each other, it is thought that the educational context of the A-TR case was the most competent. Hence, the most powerful indicators in this field referring to 'theories and concepts of sustainability were used to reflect upon everyday knowledge and actions' and 'sustainability topics were integrated into internal preschool curricula' were fully fulfilled in the A-TR case. Indicators referring to 'purchasing policies for supplies, equipment and food are based in equal measure upon environmental and social sustainability and on economic viability' and 'adults provide children with the opportunity to learn, appreciate and compare cultural diversity' were partially fulfilled, and all the other indicators were fully fulfilled in the A-TR case.

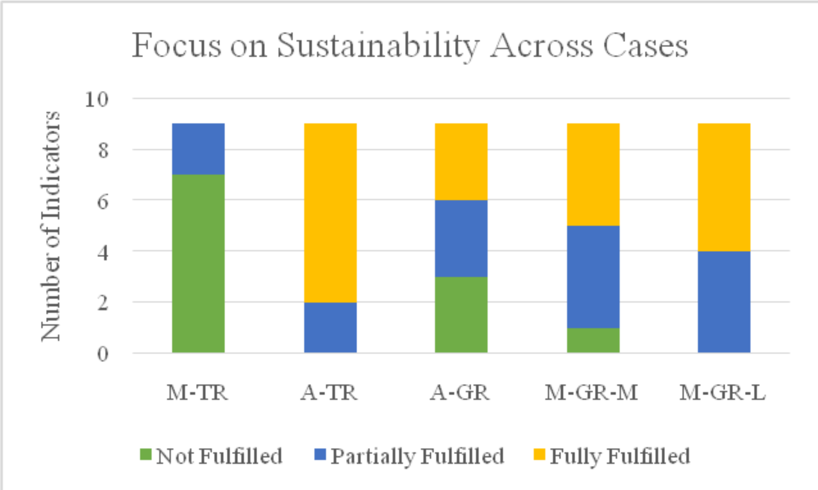

Figure 104. Focus on sustainability across cases

In second and third ranking were the M-GR-L and M-GR-M cases, respectively. In both cases, resources were carefully managed by reducing, reusing, and recycling, and adults provided the definition of the term "diversity" in a multi-dimensional ways, showed acceptance of people in their differences, and provided children with the opportunity to learn, appreciate and compare cultural diversity. Again, in both cases, theories and concepts of sustainability were partially used to reflect upon everyday knowledge and actions, purchasing policies were partially sustainable, and sustainability topics were partially integrated into the internal preschool curricula. The main difference between the cases in the M-GR preschool stemmed from the existence of the second teacher in the M-GR-L case, who had received training in the field of nature education and was able to provide the children with rich experiences to learn, appreciate and compare diversity in nature.

The A-GR case was considered to be in fourth rank in relation to sustainability. In this case, the adults provided the definition of the term "diversity" in a multi-dimensional way, showed acceptance of people in their differences, and provided children with the opportunity to learn, appreciate and compare cultural diversity. The purchasing policies indicator in this case were partially sustainable, resources were carefully managed by reducing, reusing and recycling, but there was no structured approach to focus on diversity in nature, however the children were allowed to explore nature freely; thus, it was concluded that this indicator was also partially fulfilled. The other three indicators related with the integration of sustainability into everyday knowledge, actions, and the curricula were not fulfilled. A further finding was that teaching staff did not have a background understanding of this issue.

It is revealed that M-TR was the least competent in terms of the focus on the sustainability aspect. Indicators referring to ‘resources are carefully managed by reducing, reusing and recycling’ and ‘adults provide children with the opportunity to learn, appreciate and compare diversity in nature’ were only partially fulfilled in this case. The other indicators were not fulfilled at all.

4.4.4.6 Systems Thinking Aspects

In this part, 17 indicators are discussed, and the extent to which the indicators were fulfilled is presented in Table 47 and Figure 105.

In this part, there are four common aspects in all cases as follows; the children were not engaged in closed-loop thinking practice, adults and/or children did not use sentences with following phrases: “the more, the more” “the less, the less” “the more, the less” “the less, the more”, the adults and children did not discuss what would happen if a component was added to or removed from a system, there were no conversations about hidden components and processes in systems, and children only partially become involved in conversations related to the past-present-future connection.

As seen in Figure 105, M-GR-L was the most competent in this part. M-GR-M was second with a slight difference. Mathematical reasoning materials were found in both cases, and the children were involved in mathematical reasoning experiences and engaged in one-way causality building experiences, subject-matter knowledge was very important, and the children become entered into conversations related to time and future prediction. Again, in both cases, children were partially allowed to encounter real-life problems, adults partially provided opportunities for children to solve problems on their own and the indicator referring to ‘there are conversations about root causes’ was also partially met. In terms of ‘children become involved in conversation related to past-present-future connection’, it was concluded that the extent of the conversations were limited. In these two cases, one of the indicators that differed from the other three cases was ‘there are conversations about how systems work’, which was completely fulfilled by M-GR-L, but only partially by M-GR-M. The difference here is considered to have emerged because of the second teacher assigned to the M-GR-L case and natural systems activities that she was conducting in that period.

Table 47. Systems thinking aspects across cases

6. Systems Thinking Aspects	**M-TR**	**A-TR**	**A-GR**	**M-GR-M**	**M-GR-L**
6.1 There are educational materials concerning the use of mathematical reasoning exercises such as numeration, pattern building and discrimination of size	F	F	P	F	F
6.2 Children practice mathematical reasoning experiences such as numeration, pattern building and discrimination of size	F	F	P	F	F
6.3 Children are engaged in one-way causality building experiences	P	F	N	F	F
6.4 Children are engaged in closed-loop thinking practices	N	N	N	N	N
6.5 Adults and/or children use sentences with following phrases: “the more, the more” “the less, the less” “the more, the less” “the less, the more”	N	N	N	N	N
6.6 Adults ask questions such as “what was this story about?” and “give a title to the book” during the book reading activities	N	F	N	N	N
6.7 There are conversations about how systems work	N	N	N	P	F
6.8 Adults and children discuss about what would happen if a component was added to or removed from a system	N	N	N	N	N
6.9 Children were let to encounter real-life problems	P	P	F	P	P
6.10 Adults provide opportunities for children to solve problems on their own	P	P	F	P	P
6.11 There are conversations about hidden components and processes in systems	N	N	N	N	N
6.12 There are conversations about root causes	N	N	N	P	P
6.13 Subject-matter knowledge is very important in this learning environment	F	N	N	F	F
6.14 Children were engaged in imagination practices	P	F	F	F	F
6.15 Children become involved in conversations related to time	F	N	N	F	F
6.16 Children become involved in conversation related to past-present-future connection	P	P	P	P	P
6.17 Children become involved in conversations related to future-prediction	N	N	N	F	F

N: The indicator was not fulfilled
P: The indicator was partially fulfilled
F: The indicator was fully fulfilled

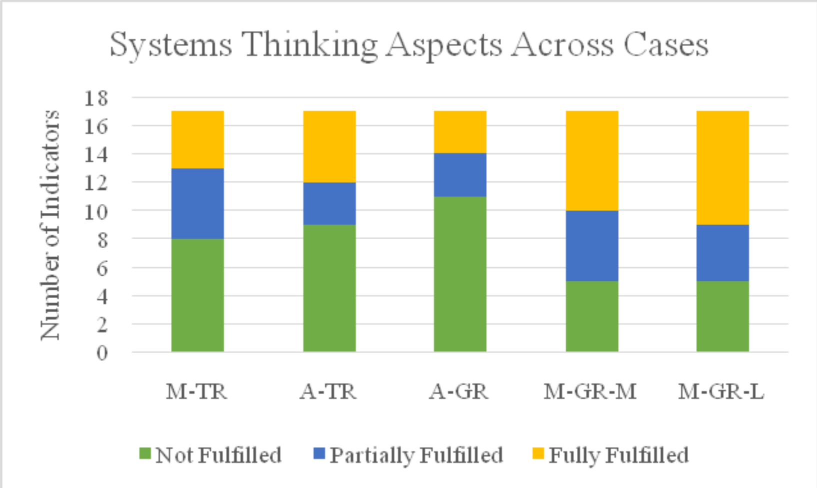

Figure 105. Systems thinking aspects across cases

The A-TR case ranked third according to the findings. Mathematical reasoning materials were found in this case and the children practiced mathematical reasoning experiences; they also engaged in one-way causality building experiences and imagination practices. However, the indicator that was fulfilled in this case but not fulfilled in other cases was ‘adults asked questions such as “what was this story about?” and “give a title to the book” during the book reading activities’.

In fourth position was the M-TR case in which mathematical reasoning materials were found, and the children practiced mathematical reasoning experiences, subject-matter knowledge was very important, and children become involved in conversations related to time. There was no indicator that was fulfilled by this case that was not fulfilled by the others.

M-GR ranked last in terms of fulfilling indicators related to systems thinking aspects, mainly due to the lack of educational content. Due to the free atmosphere in this case (see the description regarding free play), the children were extensively engaged in imagination practices. There were two indicators which were fully fulfilled in this case but were not fulfilled or only partially fulfilled by the other cases. Due to the open pedagogical concept utilized in this case, the children were completely left to encounter real-life problems, and the adults fully provided opportunities for the children to solve problems on their own.

4.4.5 Educational Contexts Within Cases

In this part of the thesis, within-case analysis findings on educational contexts are presented. This will be achieved by comparing and contrasting the findings related to the mainstream educational context in Turkey and Germany, and the alternative educational context in Turkey and. Germany. Before engaging in this analysis, it is useful to present a brief comparison of the ECE systems in the two countries.

4.4.5.1 Early Childhood Education in Turkey vs. Early Childhood Education in Germany

As presented in the first part of the findings chapter, the ECE system in Turkey and Germany differ in many respects, such as:

- Germany has a longer history and experience in the field of ECE
- ECE enrolment rates are much higher in Germany
- Annual expenditure per student in Germany is three times that of Turkey (2412 USD in Turkey, 8351 USD in Germany)
- Ratio of students to teaching staff in Germany is better (12 in Germany, 21 in Turkey)
- ECE teachers in Turkey work more hours (ECE teachers in Turkey work 1080 hours per year, ECE teachers in Germany work 796 hours per year)
- Teachers employed in Turkey's earlier education system have received different training and qualifications, resulting in both high school graduates and bachelor degree holders existing in the system. The professional characteristics of the ECE staff in Germany were more similar, with most of them having a vocational high school degree.

There are a few similarities between the ECE systems in Turkey and Germany:

- Total public expenditure on education is the same in both countries (11% of total expenditure in both countries)
- Total expenditure on educational institutions as a percentage of GDP are very similar (4% in Turkey, 5% in Germany)
- Share of private expenditure on ECE institutions are similar (18% in Turkey, 20% in Germany)

4.4.5.2 Mainstream and Alternative Education Cases from Turkey vs. Mainstream and Alternative Education Cases from Germany?

On a country basis, there are similarities and differences, with the main differences in the educational contexts within countries being:

- Preschools from Germany had more structural approach towards participation, conflict resolution, communication, staff development and cooperation with the world outside the preschools.
- Physical qualities (such as availability of service areas; indoor and outdoor space per child; available materials, equipment, and toys) of the preschools were better in the cases belonging to Germany.
- Children belonging to the cases in Germany were more independent and self-sufficient, which was due to the adults providing children with the space to participate in decision-making processes in line with their age and abilities, and adults encouraging children to do things for themselves.
- The educational context in Germany was multi-cultural, and in all cases from Germany, the adults provided children with the opportunity to learn, appreciate and compare cultural diversity.

The similarities in the educational contexts within the two countries were:

- A multidisciplinary approach was utilized in all the cases
- In all the educational contexts, no educational evidence was encountered concerning closed-loop thinking and adults and/or children did not use sentences containing the following phrases: “the more, the more” “the less, the less” “the more, the less” “the less, the more”.
- In none of the cases did adults and children discuss what would happen if a component was added to or removed from a system and there were no conversations about hidden components and processes in systems.
- All of the cases only partially fulfilled the indicator referring to ‘children become involved in conversation related to past-present-future connection’.

4.4.5.3 Mainstream Educational Context from Turkey vs. Mainstream Educational Contexts from Germany

When mainstream educational context comparisons were made on country basis, differences and similarities came to light. The differences within countries were:

- Teachers in the German mainstream cases had expertise with specific age groups and different disciplines. More than one teacher was assigned to the mainstream cases from Germany. There was one teacher assigned to the mainstream case from Turkey. She did not have expertise in teaching any age group. She had been teaching the same group of children for the last three years.

- Cases from Germany had a more structural approach towards participation, conflict resolution, communication, staff development, and cooperation with the world outside the preschools.
- Physical qualities (such as availability of service areas; indoor and outdoor space per child; available materials, equipment and toys) of the preschools were better in the cases belonging to Germany.
- The teacher of the mainstream case in Turkey was very dominant, and the educational context was very adult centered, whereas the teachers of the mainstream cases in Germany were co-learners and co-players, and the educational context was more child-centered.
- Children belonging to the mainstream case in Turkey had shallow learning experiences when compared to the mainstream cases in Germany, with mostly rote-learning being practiced in the case from Turkey. Deep project learning was observed in the German mainstream cases. The children in the German mainstream cases were posed cognitively challenging questions by the teachers and were provided with open-ended practices, and the teachers displayed flexibility when creating learning opportunities. There were wrap-up or reflection exercises at the end of the activities. Those indicators were not fulfilled in the Turkish mainstream case.
- Learning experiences in the German mainstream cases were both multidisciplinary and interdisciplinary due to the existence of the deep project work. Learning experiences in the Turkish mainstream case were multidisciplinary.
- Almost all the decisions in the Turkish mainstream educational context were taken by the adults. Children could not use the limited materials without adult supervision, and they did not have time and space to use materials. Children belonging to the cases in Germany were more independent and self-sufficient due to the adults providing them with the space to participate in decision-making processes in line with their age and abilities, and adults also encouraging the children to do things for themselves. The children from the German mainstream cases had access to abundant materials and had the time and space to use those materials. The mainstream educational context in Germany was multi-cultural and multi-lingual, and the adults provided children with the opportunity to learn,

appreciate and compare cultural diversity. The mainstream educational context in Turkey was monocultural and monolingual.

- Practices in the mainstream education cases from Germany were more in line with the sustainability theories and concepts.
- Adults in the German mainstream cases were more open in terms of approaching to diversity in general, cultural diversity and accepting differences in particular. The adults in the Turkish mainstream cases were limited in their approach to diversity, and they were judgmental in terms approaching differences between the children.
- There was more evidence regarding the systems thinking indicators in the German mainstream cases than the Turkish mainstream case.
- Children become involved in conversations related to future-prediction in German mainstream educational contexts, whereas those types of conversations were not observed in the Turkish mainstream educational context.

The similarities of the mainstream educational contexts within countries were:

- It was observed that classroom approach and age-based segregation were utilized in the mainstream cases of both countries.
- Even though the quality of the work on documentation differed between the two countries, a documentation technique that allowed children to monitor their learning experiences was utilized in both countries.

4.4.5.4 Alternative Educational Context from Turkey vs. Alternative Educational Context from Germany

When alternative educational context comparisons were made on country basis, differences and similarities were observed. The differences in the alternative educational contexts within countries were:

- The alternative educational context in Turkey had a structural approach to conflict resolution among the children.
- There was more evidence regarding the illustration and manipulation of the systems in the learning environment of the alternative education case from Turkey than in the German alternative education case.
- There were more educational and play materials available in the Turkish alternative education case.
- There was no educational structure in the German alternative education case. The pedagogy of the preschool was based on free exploration and free play. There was a rich educational content in the Turkish alternative education case.

- Documentation in German alternative education case was better in terms of enabling the children to observe their learning processes throughout time.
- In the alternative education case from Turkey, in terms of thinking and acting routines, cognitively challenging questions were frequently observed, adults listened for and encouraged children's thinking in more engaged way, adults were relatively better focused on individual children, and there were more opportunities for children to participate in decision-making processes in line with their age and abilities. However, the German alternative education case provided more extensive free play and encouraged children to do things for themselves.
- The Alternative education cases from Turkey and Germany were very different in terms of fulfilling the sustainability indicators. Other than the purchasing policy and the cultural diversity aspects, the Turkish alternative education case was more able to fulfill all the indicators. The German case was in similar position regarding the purchasing policy; however, this case was more competent in adopting approaches and practices in the field of cultural diversity.
- There were more mathematical reasoning materials and exercises, one-way causality building exercises, and question asking exercises at book reading activities in the Turkish alternative education case. In the German alternative education case, the children were encouraged to encounter real-life problems, as well as being provided with opportunities to solve problems on their own.

The similarities in the alternative educational contexts within countries were:

- The alternative educational contexts from Germany and Turkey had a similar approach to participation, communication among staff, conflict resolution, staff development and training, and opening up external learning spaces to the children.
- The children belonging to the alternative education cases from both countries had access to most parts of the indoor and outdoor environment.
- The approach to learning experiences in both cases were fragmentized and multi-disciplinary, with no connection between disciplines and learning experiences being observed.
- The children could talk freely and ask questions in both cases. The Adults partially created open-ended experiences to foster creativity, and partially displayed flexibility when creating learning opportunities. There were no wrap-up or reflection exercises at the end of the activities.

- Adults provided the definition of the term “diversity” in a multi-dimensional way and showed acceptance of people in their differences.
- Both of the cases were relatively less competent in terms of the indicators related to systems thinking aspects: children were not engaged in closed-loop thinking practices, adults and/or children use sentences with following phrases: “the more, the more” “the less, the less” “the more, the less” “the less, the more”, there were no conversations about how systems work, adults and children did not discuss what would happen if a component was added to or removed from a system, and there were no conversations about root causes, hidden components, and processes in systems. Subject-matter knowledge was not very important in those learning environments. Children did not become involved in conversations related to time in general, future-prediction in particular.

To conclude, this chapter was divided into three parts. First part included the findings gathered for the aim of understanding systems thinking skills of preschool children. In the second part, the educational context of child participants were presented. Lastly, cross case analysis findings were provided to reveal the potentially most relevant educational contextual factors that may have an effect on child participant’s systems thinking skills. Profile and systems thinking skills and characteristics of the educational contexts are presented in cross-case matrix presented Table 48. In the next chapter, findings of this thesis study will be discussed.

CHAPTER 5

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

In this part of the thesis, findings related to the systems thinking skills of 4- to 6-year-old preschool children and the interaction patterns among those skills within the Turkish and German educational contexts are discussed. In order to achieve this objective, firstly, findings in response to the first research question, the nature of the young children's systems thinking skills will be discussed based on Systems Thinking Developmental Rubric for K-Level in order to conceptualize a child's early steps toward systems thinking. The findings of this study on young children's systems thinking skills will be considered in relation to the extensive literature developed in different disciplines. In the following parts of this chapter, factors related to the nature of the child (hereditary cognitive individual differences, age, and gender) and environmental factors (parent education level, raised as bilingual) will be discussed.

Secondly, the educational contextual factors that exist in the visited cases that may have an effect on those young children's systems thinking skills will be reviewed according to the descriptions of the contexts which is based upon the synthesis through a cross-case analysis obtained from supervised activities observation form, learning environment observation form, adult interviews, field notes, reflexive journals and additional documents through the lens of the Sustainability and Systems Thinking Indicators Checklist.

5.1 Discussion of Findings

5.1.1 Systems Thinking Skills of Young Children

The findings of this study indicated that young children do show some signs of complex understanding regarding systems thinking in terms of detecting obvious gradual changes, two-step domino and/or multiple one-way causalities, as well as describing behavior of a balancing loop. However, their capacity was found to be limited in detecting a reinforcing loop, understanding system mechanisms which acknowledges the unintended consequences, detecting hidden components and processes, demonstrating multi-dimensional perspective, solving the problem through high-leverage interventions, and predicting the future behavior of the system.

5.1.1.1 Dynamic Thinking

Findings related to the dynamic thinking: The children were able to notice changes in the system at the back-and-forth or existence-presence level. They were mostly able to trace the dynamic behavior noticing that there is a gradual change when a gradual time-perspective was given. However, they could not detect a circular dynamic behavior pattern through a much longer time-view by incorporating both obvious and hidden components and processes.

In general sense, the term ‘analogy’ can be defined as the ability to reason by means of associational patterns (English, 2004). Being able to detect patterns, as well as diagnosing the reoccurrences of patterns in the face of variations in their elements, then drawing conclusions from the patterns, and finally conveying these abstractions are seen as basic human achievements (Gentner, Holyoak & Kokinov, 2001). Essentially, being part of the core of human cognition, analogy appears to be tightly connected to the development of general representational ability (Gentner & Rattermann, 1991; Hofstadter, 2001). In the process of developing mathematical inquiry, pattern exploration has been identified as a central construct. It has also been singled out as a fundamental element of children’s mathematical growth (Burns, 2000; Clemson & Clemson, 1994; Heddens & Speer, 2001; NCTM, 2000). Among the three categories of patterning; namely repeating, growing, and relationship, repeating patterns are the earliest form that is explored (Burns, 2000), while growing and relationship types of patterns are harder to comprehend. In this study, all three categories of patterning were present. The findings of the study revealed that children were able to recognize repeating, growing and lower order relationship patterns, but they had difficulty in terms of recognizing and describing relationship level patterning through higher order relations, which are generated between more distant or removed concepts.

For some time, it has been a matter of controversy concerning the development of young children's analogical reasoning ability (e.g., Goswami, 1992; Piaget, 1952; Sternberg & Rifkin, 1979). It is only in recent years that young children’s ability to reason analogically has been acknowledged (English, 2004). English (2004) argued that the main reason for this lack of attention was due to the dominance of Piagetian theory (Piaget, 1952; Inhelder & Piaget, 1958), which maintained that because of their inability to reason about higher order relations, children are unable to solve classical analogy tasks. However, several studies indicate the existence of young children’s ability to apply patterning skills in a wide variety of situations, including simple repetition (Young-Loveridge, Peters & Carr, 1998), part–whole thinking (Hunting, 2003; Lamon, 1996; Young-Loveridge, 2002), and recognizing spatial and geometric patterns (Feeney & Stiles, 1996). Moreover, patterning is attracting significant attention in many educational contexts. As shown in the cases included in this thesis, there are endeavors to develop children’s patterning skills in the target educational contexts. On the other hand, English (2004) explained that both young children and older students have difficulties in distinguishing structural similarities, mostly due to the fact that novice solvers tend to focus on the pertinent surface features, such as specific items or objects, rather than the underlying structural properties or domain principles (Novick, 1992; Silver, 1981; Stavy & Tirosh, 1993). The findings of the current study revealed that preschool children were not developmentally able to detect hidden structural patterns in the system by incorporating both obvious and hidden components and processes. Accordingly, other studies focused on complex systems revealed that significant obstructors to understanding are constituted by invisible and dynamic phenomena (Feltovich, Coulsen, Spiro & Dawson–Saunders,1992).

The developmental approach to analogical reasoning is also supported by research in the field. For example, Gentner (1988) noted that a relational shift is seen in children's ability to identify structural relations with development; in other words, they proceed from processing object-based commonness to processing higher order relational similarities.

The nature and extent of the knowledge base of children, including their conceptual, relational, and conditional knowledge, is the other significant parameter that should be evaluated when defining children's analogical reasoning ability (Alexander, Murphy & Kulikowich, 1998; Brown, 1989; English, 1998; Goswami, 1992; Vosniadou, 1995). The descriptive, surface features without systems-specific content knowledge appeared to be ignored (Sweeney & Sterman, 2007). This argument is supported by different responses given by the children in the current study. The first example was seen at the beginning of the water hole story. On the first page of the story, only a large water hole is depicted, and the children were told that environmental changes, such as floods and drought occurred in other regions with the change of seasons, and for this reason, the animals living in this region migrated and started to gather around the water hole. Interestingly, during the interview, the children did not refer to this event that was not pictured in the book. In another example, focusing on the question of "why has the water decreased", the children were asked to provide possible reasons for the gradual decline of the water. The most popular of the children's responses to the question was that the water was drunk by the animals. As previously presented in detail, the children were dominantly preoccupied with clear events, rather than the hidden levels of the system. However, it should be recalled that some children also formed different theories on water reduction: it went underground, evaporated due to the lack of rain, something in the bottom (beaver and magnet) pulled the water down, and there might have been a fire. The children of the M-TR case gave more conventional responses by focusing on the seen-events with respect to the cause of water decline, and it was observed that the children in other cases gave rather more unconventional responses and were able to take into account other possibilities not present in the story[43].

Research shows that most students do not have a clear comprehension of the nature of decay (e.g., Hogan, 1994; Leach, Driver, Scott & Wood-Robinson, 1996). In order to understand the concept of decay, a non-obvious causal mechanism must be recognized in addition to coping with the time delay associated with nutrient recycling and the embedded cyclic causal model (Bell-Basca, Grotzer, Donis, & Shaw, 2000). Research also shows that students aged 7 to 10 start to use more concepts related to matter recycling, including the decay process (Leach, Konicek & Shapiro, 1992). The development of context-familiarity (Perkins & Grotzer, 2005) and developing cognitively as explained above could be two main reasons for this situation.

Piaget (1929) claimed that in comparison to older children, 4- to 7-year-olds have less biological knowledge and typically do not have adult-like concepts of living things. Indeed, through the interview questions posed to teachers of the children in the target cases, it was concluded that children did not have former educational experience regarding the water cycle. The most comprehensive answer to the cyclic movement of water came from the participant who openly stated that he acquired his knowledge on the subject-matter via a

---

[43] Apart from the explanations regarding the young children's developmental levels and limited subject-matter knowledge given in this section, limiting the intellectual freedom of children by not allowing them to ask questions, talk freely, choose the subject they would like to work on, and not aiming to enhance their creativity and imagination abilities through open-ended materials and learning experiences are seen as potential factors that may inhibit the M-TR case children in terms of providing unconventional responses to the posed questions. These arguments will be briefly discussed in the project-based learning section of the educational factors in this chapter.

game called “nature quiz”. Still, his conceptualization of the water cycle was not complete. This child was a member of the A-GR case. It is notable that the children’s competency levels in dynamic thinking were very different in this case. In other cases, most of the children were able to reach Level 3; thus, they were able to trace the dynamic behavior, noticing that there was a steady change when a gradual time-perspective was given. Interestingly, all the children belonging to the M-GR-L case performed at this level.

It was concluded that the children's incomplete comprehension of dynamic behavior in the system caused children to process issues only at above-the-surface level. Naturally, this situation affected the abilities of children negatively in terms of demonstrating a comprehensive understanding of the system mechanisms, proposing high leverage solutions and making broad future predictions.

5.1.1.2 Feedback thinking

Findings related to feedback thinking: Almost all of the children could close the loop by recognizing the most obvious above-the-surface level interdependent relationship between the water and animals. Only half of them continued to trace causal relationships around the loop and describe the behavior of the balancing feedback loop, noticing that the oscillating behavior continues to bounce off each relationship over time. However, they could not describe the behavior of a reinforcing loop (the population growth), which could emerge as a result of a root cause analysis.

As Sweeney and Sterman (2007) pointed out, upon realizing a cyclic behavior, learners may put an end to their inquiry and simply come up with the conclusion that the pattern repeats itself instead of attending to the feedback structure. As a result of stopping at the conclusion that a predator–prey relationship is a cycle, the child may eschew the impact of accumulation or other feedback operating in the system (e.g., the positive feedback driving population growth for both species).

Furthermore, studies of complex systems show that the main focus of understanding is the viscerally present structures (Hmelo, Holton & Kolodner, 2000; Mintzes, Trowbridge, Arnaudin & Wandersee, 1991; Wood-Robinson, 1995). Bell-Basca, Grotzer, Donis and Shaw (2000) explained that when effects are removed in time and space from their causes, children are less likely to recognize them as being connected to the precipitating events. As observed in the story which was read to the children in the interview, natural systems often have inherent mechanisms which act as checks and balances or provide assurances that would lessen effects or slow the obvious appearance of effects. That is why the effects of certain actions on the environment would be less likely to be noticed immediately. Since the outcome the children want to observe is not immediately available, they might overcorrect, rather than showing patience in waiting to see how the systems dynamics would play out and act on the overall process (Dorner, 1989). The child participants of the research referred to in this thesis were unable to identify the limits to growth behavior in the system, which constituted the basis of the story. That in turn shows that they were unable to delve into the root cause of the matter. This phenomenon has also been noted in other measured aspects of the systems thinking.

Perkins and Grotzer (2005) explain that the reason why more complex modeling styles make it harder for learners to understand the lack of familiarity with the content knowledge. Learners devise another explanation, arguing that linear relationships can be easily understood because of their familiarity. However, many concepts and theories in systems depend on styles that are substantially more complex in ways that will be defined below, such as large-scale patterns of action emergent from small-scale interactions or with cyclic causal models, as in predator-prey interactions in an ecosystem, where the prey provides food for predators and predators cull unhealthy prey and keep the prey population from exploding beyond the capacity of the environment. Instead of simply elaborating, highly complex modeling styles contradict other relatively more known modeling styles of less complex nature. They do this by challenging basic assumptions concerning how the world works, such as the magnitude of effect correlates with magnitude of cause or temporal priority between causes and effects (Bullock, Gelman & Baillargeon, 1982). It is because of such contradictions that we can tend to prefer the more simple explanation.

In this aspect, all children in the M-GR-M and M-GR-L cases were found to perform closed-loop thinking in some way. It is also interesting to note that children from the M-GR-L case exhibit an intense Level 3 performance, which means they could define the behavior of a feedback loop. In the scope of this research, performances of the children belonging to M-GR preschool could be related to their cognitive development levels which is also related to their age as well as general high-quality educational experiences. Age and educational experiences as factors affecting the approaching to complex systems will be elaborated in the next parts of this chapter. The number of children who could identify the reinforcing loop that could be defined at beyond-the-seen level in the story was very limited, and these children belonged to the A-GR and M-GR-M cases. There are children who were not able to perform closed-loop thinking in the A-GR, A-TR and M-TR cases.

5.1.1.3 Big Picture Thinking

Findings related to big picture thinking: The children in the current research had a limited ability to comprehend a given issue from a holistic perspective; they seemed to prefer to approach issues from uni-dimensional and partially multi-dimensional perspective. They generally focused on identifying parts of a system, rather than how they come together to make a whole.

Chi (2000) gave a theoretical explanation which explains why students misapprehend complex dynamic concepts like natural selection: “students focus on an object’s actions rather than its interactions, or they focus on the class of the object rather than seeing the object as a collection” (p. 19). In a study conducted with 200 children aged between 5 and 16 about the interdependency of organisms, it was discovered that children between five and seven largely imagine organisms as individuals, rather than as members of a population (Leach, Driver, Scott & Wood-Robinson, 1996).

An opinion was formed that the children from the A-TR case exhibited a more multi-dimensional approach. In the A-TR preschool, it was noted that a circle of viewpoints often occurred, with the children interacting with all the other children and adults through free play and structured educational activities, and they were able to use the physical possibilities of preschool extensively and use the open-ended materials intensively. This preschool also had a special aspect that was not found in other cases. As previously reported in the A-TR case descriptions, both the children and adults were engaged in critical thinking practices in parallel with the education for sustainability principles. The M-GR-M case was in the second rank in this aspect. Level distributions were relatively scattered, with children exhibiting both uni-dimensional, partially multi-dimensional and completely multi-dimensional perspectives.

It is believed that the inability of children to process the system at the below-surface and population level resulted in their fragmented approach to the system presented in the story.

5.1.1.4 Understanding System Mechanisms

Findings related to understanding system mechanisms: The children could not consider the possibility of unexpected changes in the system when a new component was added to the system. Less than half of the children could describe the wider and long-term potential impacts of adding the new component to the system. Again, less than half of the children could describe only potential local and short-term impacts of the addition of the new component to the system. There were also children who anticipated that there would be no change in the system at all.

In order to display this ability, it is imperative to understand that the matter at hand is a system. A study conducted to find out children's attitudes toward food webs demonstrated that they are inclined toward individual level explanations instead of those at population level. Accordingly, their predictions are often based on linear cause-and-effect sequences rather than changes throughout the food web (Leach, Driver, Scott & Wood-Robinson, 1996). When analyzing the effects in ecosystems, children often fail to recognize the connectedness within the system and the implicit complex casual relationships (e.g., Grotzer & Basca, 2003; Webb & Boltt, 1990). For example, Barman, Griffiths and Okebukola (1995) found that senior high school students were of the opinion that a change in one population will only affect another population under the condition that there is a predator-prey relationship between the two. They tended to believe that a change in one population will not be passed along several different pathways of a food web. In earlier research based on circuits (Cohen, Eylon, & Ganiel, 1983), it was shown that the reason why the high school students tend to engage in local analysis of changes in the circuit is that they used a substance notion rather than a process notion of electrical flow. The logic for this was due to the difficulty of approaching the circuit as a system and considering its behavior as a whole; rather, the students tended to focus on parts of it.

Grotzer (1989, 1993) indicated the importance of age in explaining, in part, the tendency to ignore indirect effects. She demonstrated that in comparison with 9- and 11-year-olds, seven-year-olds were less likely to realize indirect effects. Barman and Mayer (1994) demonstrated that high school students defined a food web as a more realistic representation of feeding relationships. However, when probed as to what would happen to an ecosystem if the fox population were to be reduced or the rabbit population doubled, the students were confused regarding the mutual relationships within a food web. The general tendency among the students is to believe that a change in the size of a prey population has no influence on its predator's population. Students do not think in terms of populations and they fail to comprehend the systemic implications of what they know.

It the current study, it was concluded that the children approach the issues horizontally (time-wise) and vertically (space-wise) in a limited fashion. As a result, the children are less likely to recognize the possibility that small changes in the system can cause significant consequences, and they omit the possibility of the unexpected changes in the system. Kuhn, Amsel and O'Loughlin (1988) demonstrated that previous expectations held by the children make it harder for them to perceive contradictory issues in relation to these expectations. The authors showed that it was difficult for the elementary school students to discern instances where a variable is non-operative or is operative but does not lead to the expected outcome.

In this aspect, in the current study, the children in all cases except M-GR-L performed in a similar manner. Children from the M-GR-L case performed relatively better than the other children, and a child in this case could consider the possibility of unexpected changes in the system when a new component was added to the system. It is thought that one of the reasons behind this may be related to activities undertaken about systems in nature in this learning group.

5.1.1.5 Problem Solving

Findings related to the problem solving: The young children’s problem-solving ability in a given problematic system behavior was limited; they either left the problem untouched or exhibited a short term symptomatic approach, which eroded the capacity for fundamental solutions. They were not aware that those solutions would create new problems. Only a few of the children demonstrated a longer term diagnostic approach by focusing on possible root causes or offering more sophisticated intervention points, such as acting in time (being aware of the delay in the system) or distributing the resource fairly.

English (2004) concluded that children tend to focus on the common surface features of the problems, and their representations of the problems often lack the appropriate relational structures required for reasoning by analogy. Even in situations where children did demonstrate relational understanding, they tended not to spontaneously reason analogically, and if they did, they often experienced difficulty in adapting the source to the solution procedure (English, 2004). Senn, Espy and Kaufmann (2004) suggested that for five- and six-year-olds' ability in complex problem solving, the working memory may play a large role. Andrews and Halford (2002) posited the relational-complexity theory, hypothesizing that the younger children have more limited resources in terms of building a complete complex analogy. The level of maturation in children's short-term and working memory may explain the number of relations that children can manage.

It was witnessed that some of the children in the current study offered unconventional suggestions to solve the water scarcity problem in the story. It is considered that children belonging to the M-GR-M and M-GR-L cases offered multiple solutions in the problem-solving aspect, and some were appropriate to be evaluated as unconventional responses. An important number of the children who gave the answer "I would do nothing" or gave irrelevant answers belonged to the M-TR case. However, some of the children from this case also provided unconventional responses to the problem solving question. This can be explained by the lack of inhibition in the early childhood years. Kohlberg (1984) pointed out that children are not inhibited by rules or the expectations by the others. Isbell and Yoshizawa (2016) argued that this characteristic in early childhood give children the freedom to present ideas without any concern about how their efforts could be evaluated. Kelley and Kelley (2013), Lehrer (2012), and Runco (2014) saw benefits of this characteristic as breaking the shackles of perceived restraints and freeing the creative thinker, as well as encouraging the flow of unconventional ideas. Apart from the developmental explanations provided above, limiting the social and intellectual freedom of children observed frequently in the M-TR case is considered as one of the potential factors that may have a negative effect on the children's creative problem-solving abilities. This issue will be addressed in the educational factors section of this chapter.

5.1.1.6 Hidden Dimension

Findings related to hidden dimension: The abilities of children fell short in terms of detecting hidden components and processes in the system. They mostly operated with the readily seen components and processes in the system.

The limitations of children that participated in the research on "seeing beyond the seen" skill was explained in other aspects of the systems thinking. The responses of the questions that aimed to reveal the children's abilities on hidden components and process within system showed that young children can detect system components and processes in a narrow frame.

In order to explore the abilities of the children to look beyond the seen, children were asked five different questions: Where did the water come from? Why has the water decreased? Where did the water go? Where did the animals go?, and Who/what else needs/uses water? When the responses of those questions were examined, it was seen that the children tended to produce ideas by using obvious components and processes. It is thought that the ability to handle the system through hidden components and processes was not exhibited by most of the children. For example, when the children were asked where the water pictured at the beginning of the story might have come from, 20 children (38.5%) did not give a valid response. Concerning the question about where the water may have gone, the most frequent response was “the water was drunk by animals” which is related to the readily seen event. Focusing on the question of “why has the water decreased”, the children were asked to provide possible reasons for the gradual decline of the water. Again, the most popular response was related to a readily seen event; the water decreased because it was drunk by animals. When in the book there was a page on which the animals are not visible, the children were told, “... the animals have gone”, and then the question, “where might the animals have gone”, was posed. Twelve of the children gave irrelevant answers or left the question unanswered. The most frequent response was “to another place where water exists” (animals went to their homes with water, another forest with water, a new water hole, or another country with water). Sixteen children, approximately one-third of the participants, stated that they did not know the answer to the question of “who else or what else needs/uses water” or remained silent. As expected, the most frequently mentioned component requiring water was people with a frequency of 29. The second most frequently mentioned component was plants with a frequency of 19. It was deduced that even the children who mentioned components, such as human beings and plants could not address these within the system approach; rather, they focused on the individual components.

The general tendency of younger children rationalizing at less complex levels and older children at more complex levels of the dimensions is supported by a significant part of developmental research. For example, research on thinking about gears revealed that younger children are liable to consider it in functional terms (Metz, 1991) or with regards to surface level generalizations by not adding an underlying mechanism, though older children added an underlying mechanism (Lehrer & Schauble, 1998).

Children seem to have difficulty in identifying non-apparent causes. Some hidden components appear to conceal a causal relation or add in processes in unforeseen styles. Brinkman and Boschhuizen (1989) demonstrated in their research that many students do not comprehend the function of microbes in nature as recyclers of carbon, nitrogen, water, and minerals.

In the current study, the most frequent advanced responses were provided by four children who belonged to the M-GR-M case. In addition to the hidden components, those children could describe some hidden processes. In the M-GR-L case, stacking up was heavily seen at a specific level, and children at this level identified more than two hidden components. A significant number of children who did not respond to the questions given above were participants in the M-TR and A-GR cases. In these cases, especially in the hidden dimension of systems thinking aspect, it was concluded that the children's limitations in their developmental stages, subject-matter knowledge levels, and displaying relational view were at the forefront.

5.1.1.7 Time Dimension-Future Prediction

Findings related to the time dimension-future prediction: In terms of detecting the children's ability of prediction, use of short-term and long-term time intervals, and understanding, in general, how the system functions over time, it was concluded that the children constructed their predictions on existing patterns. They were very limited in terms of exhibiting broader time dimension which may help them to make future predictions through seeing the issue from a wider perspective by positioning the prediction in a larger time interval which was not only based on the existing pattern. The children did not exhibit an understanding of the sophistication in the systems. They did not grasp the extent of the sophistication of the dynamics of even a simple system, which will prevent them from foreseeing how it will act.

Empirically, research in the field of reasoning about the past and the future suggests that these two capacities coincide and are displayed a correlated manner between 3 and 5 years of age (Suddendorf & Redshaw, 2013). For instance, in language understanding, the prevalence of joint emergence and systematic correlations between past and future cognition are found (yesterday/tomorrow) (Busby & Suddendorf, 2005) and tasks involving the concept of a past self (delayed self-recognition) and the concept of a future self (delay of gratification) (Lemmon & Moore, 2001). The foundation of the development of the temporal language is based on cognitive changes at around 3 to 5 years of age (Friedman, 2004; Hudson, Shapiro & Sosa, 1995), episodic memory (Gopnik & Graf, 1988; Perner & Ruffman, 1995), and future planning (Atance & Jackson, 2009; Russell, Alexis & Clayton, 2010).

The enhancement of the appreciation of temporal–causal relations between events and the development of capacity to apply this explicit conceptual representation flexibly to past and future contexts are components of mature thinking about time (Lohse, Kalitschke, Ruthmann, & Rakoczy, 2015). There are studies suggesting an asymmetry such that past-directed temporal causal reasoning precedes future-directed temporal-causal reasoning, and that at around 4 or 5 years of age temporal–causal reasoning emerges (McColgan & McCormack, 2008; McCormack & Hoerl, 2007), which is also corroborated by the research findings presented in this thesis. In a study focusing on the preschoolers' ability to report temporally displaced events, Suddendorf (2010) reached a conclusion that 4-year-olds performed significantly better than 3-year-olds in answering future questions, while age differences on the past-time related questions were not significant. He explained this situation by stating that the future reasoning requires creative construction, whereas the past has, in fact, happened and creative construction is not necessary.

In order to understand children's capacity to reason about temporal and causal relations among past, present and future events, Lohse, Kalitschke, Ruthmann and Rakoczy (2015) conducted research with 160 4- and 6-year-olds. According to their results, while 4-year-olds showed limited competence in both retrospective and prospective tasks, 6-year-olds mastered in both categories. It was concluded that there is a qualitative difference between the flexible temporal–causal reasoning which develops in parallel for past- and future-directed reasoning and simpler forms of temporal cognition, which develops during the late preschool years. As opposed to earlier research, there was a lack of evidence of an asymmetry between past- and future-directed temporal causal reasoning.

In the current research, children who performed relatively better made future predictions through seeing the issues from a wider perspective, and they positioned prediction in a larger time interval and made predictions not only based on the existing pattern. Those children mostly belonged to the M-GR-M and M-GR-L cases. Parallel to the explanations given above, it is thought that this situation may be related to the development levels of children. In addition, the following issues emerged in observations undertaken in these cases: children were frequently asked about future prediction questions, and there is evidence that adult-child conversation styles affect a child's reports of the past (McGuigan & Salmon, 2004) and future events (Hudson, 2006). Additionally, in the M-GR preschool case, it was revealed that documentation enabled the children to observe their own learning processes, and the children's learning and experience were expanded to a longer process through deep project learning. These issues will be addressed in detail in the educational factors section of this chapter.

5.1.1.8 One-Way Causality

Findings related to one-way causality: In contrast, the children demonstrated a relatively better understanding of building one-way relationships between one cause-one effect, multiple causes and/or multiple effects, and two-step linear connections that result in direct and indirect effects. However, they were mostly unable to describe an extended linear pattern that includes a multi-step linear connection of three or more steps with indirect effects.

In terms of the skill levels of children related to the one-way causality aspect, it was concluded that children who belonged to the M-GR-M and M-GR-L cases performed better. Since it was set out in the educational contexts contents, scientific inquiry techniques were heavily used in both of the cases, and teachers assisted children in the process of building linear cause-and-effect relationships by asking "why" questions. As Brazelton (1992), Grotzer (1993), Lakoff and Johnson (1980), and Sweeney and Sterman (2007) argued when faced with more complex interaction patterns, people tend to focus on one-way causal structures. According to Green (1997), people are inclined to construct one-way linear chains when explaining the economic and human relationships although many systems involve complex chains of cause and effect encompassing two-way causal processes. Green found that without cues, only 16% of 20-year-olds could explain the predator-prey relationships in a two-way causal account. Furthermore, when confronted with a three-level problem, only 9.5% of the participants used two-way causal models.

Andersson (1986) suggested that this simple linear arrangement fits well with our most primitive notions of causality, which Lakoff and Johnson (1980) first introduced as the notion of "experiential gestalt of causation" (EGC). Children learn to expect this pattern at a very early age. Andersson argued that children, while acting upon their environments, acquire the knowledge that the actions of an agent (themselves) can impact on objects, such as toys, blankets, bottles, and parents. The interaction occurs on a one-to-one level. When the efforts of the agent are intensified, it will impact on the object in an intensified manner. Children discover that if the object is nearer, then the effect is equally greater. According to Andersson, this underlying pattern of reasoning or EGC can be detected in the ways students think about a variety of science concepts.

Furthermore, Bullock, Gelman and Baillargeon (1982) suggested that it may be in human nature to expect certain causal contingencies to hold true, such as determinism which assumes that causes precede or coincide with their effects and that the causal relation is always unidirectional. Therefore, the fundamental answer to the question why children cannot be considered as natural systems thinkers rests upon the nature of the child’s mind and the knowledge level of the child. Another alternative response to this question is related to systems thinking not being a natural act. As argued by Valerdi and Rouse (2010), this is connected with the human evolution since it favors mechanisms tuned to dealing with immediate surface features of problems. In support of their view, Valerdi and Rouse (2010) turned to Jared Diamond’s book “Collapse” (2005) to provide examples regarding this surface-level programmed human tendency. Simon (1955) proffered another explanation for the lack of systems thinking which is that it may be bounded rationality. The argument is that due to the complexity of the systems, our cognitive capabilities are overwhelmed. Due to the incomprehensible intricacy of some complex systems, a reduction reaction transpires which contains the necessary skills to become a systems thinker.

Recent studies exploring how the child’s mind functions highlight the executive function of the brain. It was shown for the first time that a child’s executive function (EF) has a role in the development of complicated analytical thinking, as demonstrated by Richland and Burchinal (2003) in their article entitled “Early executive function predicts reasoning development”. The ability to control cognitive actions is the generally accepted definition of EF. Complex skills, such as planning, monitoring, task switching, and controlling attention become available due to EF since it both inhibits impulsive task responding and manipulates and organizes complex information while holding it active in working memory (Diamond, 2002; Stuss, 2007). In the explanation of analogical capacity in children, the role of inhibitory control and additional working memory aspects of EF have been underscored (Richland, Morrison & Holyoak, 2006; Thibaut, French & Vezneva, 2010).

Throughout life, EF continues to play an indispensable role in the arc of reasoning skill, increasing with age in childhood (Burns, Nettelbeck & McPherson, 2009).

The characteristics of the individual child (nature of the child), environmental factors (nurture of the child), and exposure to specific activities and early learning curricula affect EF, as with any other complex thinking skills (Ackerman & Friedman-Krauss, 2017). Furthermore, EF also follows an age-related, developmental trajectory. In the following parts of this chapter, factors affecting nature of the child (hereditary cognitive individual differences, age, and gender), environmental factors (parent education level, raised as bilingual) will be discussed. Hereafter, educational factors will be addressed in a different section in this chapter.

5.1.2 Child Factors

As demonstrated by the research in the field, EF is highly dependent on human brain development (Anderson & Reidy, 2012; Cartwright, 2012). While infants display emerging EF (Hughes, 2011), the growth of EF is especially observed among 3–6-year-olds, which is mirrored by rapid development of the prefrontal cortex (Kagan & Herschkowitz, 2005; Thompson & Nelson, 2001), an area of the brain thought to underlie EF (Blair & Ursache, 2011; Zelazo, Blair & Willoughby, 2016). A large body of research indicates the significance of the early childhood period in which the most dramatic growth in EF skills occurs, with the development of EF continuing into the adolescent and early adult years (Center on the Developing Child at Harvard University, 2011; Hughes, 2011; Thompson & Nelson, 2001).

The existence of individual differences in children's EF at any given age is an accepted notion (Ackerman & Friedman-Krauss, 2017), and this has also been corroborated in the research reported in this thesis. Indeed, the level of various EF skills among pre-kindergarten children makes it possible to predict their future EF levels two years later (Cuevas, Hubble, & Bell, 2012). Hughes (1998; Hughes & Ensor, 2005) and other authors (Carlson, Moses & Claxton, 2004; Carlson & Moses, 2001) found that individual differences in EF skills were significantly related to children's theory of mind (i.e., the ability to reason about mental states of self and others) both concurrently and longitudinally in preschool years. These findings provide the most realistic explanations as to why children at the same age in the current research referred to in this thesis displayed varying skills.

During the early childhood period brain development has an essential part through which a young child gains vital physical, motor, cognitive, social, emotional and language skills (UNICEF, 2017). The formation of neural connections occurs at an astounding pace in the first few years of life, more than 1 million per second, (Center on the Developing Child at Harvard University, n.d.) never to reach such levels in the subsequent part of life cycle (UNICEF, 2017). Needless to say, months even days matter in terms of cognitive skills of a young child. Parallel to the findings of the current research, age plays a significant role in the development of the EF capacity (Kochanska, Coy & Murray, 2001; Loeher & Roebers, 2013) and it is argued in this thesis that as children grow older, their average score of the systems thinking increases. While there is a slight average score increase between the ages of 4 and 5, this change is more dramatic in children between 5 and 6 years of age.

The findings from the current research did not find any clear effect of gender on the systems thinking skills of the participant children. However, some research argues the opposite, suggesting that gender differences could play a role in how quickly young children develop certain EF skills (Fuhs, Farran, & Nesbitt, 2013; Kochanska, Coy & Murray, 2001; Son, Lee & Sung, 2013; Storksen, Ellingsen,Wanless &McClelland, 2015). Nonetheless, additional recent research suggests that these gender differences may be culturally dependent (Oh & Lewis, 2008; Wanless et al., 2013).

Since the measurement of children's systems thinking skills is reliant on verbal communication, it is imperative to take into consideration the relationship between the receptive and expressive language skills of the preschoolers and the development of EF. The development of cognitive and language skills go hand-in-hand. For instance, both the EF capacity at the age of 5, and the development of the EF skills between the ages of 3 and 5 are related to the extent to which children's vocabulary grows between the ages of 15 and 36 months (Kuhn, Willoughby, Vernon-Feagans, Blair & Family Life Project Key Investigators, 2016).

As demonstrated in a study of 191 children between ages of 4 and 6, when the verbal ability is lower, then it can be predicted that the performance level on several EF tasks at the age 4 will also be lower (Hughes, Ensor, Wilson & Graham, 2010). Similarly, another smaller scale study executed with 39 3- to 5-year-olds concluded that it is possible to predict children's verbal working memory abilities by assessing at their oral language skills

(Ezrine, 2010). A study of the verbal ability of Head Start enrollees revealed a correlation between their development in this area and EF skills (Fuhs & Day, 2011). This thesis also found that relatively younger children are more likely to give irrelevant answers or leave questions unanswered; thus, this situation can be explained through the later development of the expressive language as explained above.

5.1.3 Environmental Factors

5.1.3.1 Parent Education Level

The level of education of the parents is one of the most significant influences on the cognitive development of the child (Ardila, Rosselli, Matute & Guajardo, 2005). Highly educated parents tend to provide environments with more intellectual stimuli for their children (Hoff, 2003a, 2003b). It has been demonstrated that in terms of interaction with their children, parents with higher education levels differ from other parents particularly in the way how they use the language (Hoff, Laursen & Tardif, 2002). In comparison to mothers with only high school education, college-educated mothers communicate more often using a richer vocabulary with their children. They also read to their children more (Hoff-Ginsberg, 1991). A study of Mexican and Colombian students aged between 5–14 years found that if the parents attended college, then the EF levels of the children were higher (Ardila, Rosselli, Matute & Guajardo, 2005). It has been demonstrated by research that there are positive connections between parental education and the language-related outcomes of the children (for example, Entwise & Alexander, 1996; Payne, Whitehurst & Angell, 1994; Walker, Greenwood, Hart & Carta, 1994). Weigel, Martin and Bennett (2006) reported on a study that examined the associations, both concurrent and longitudinal, between the indicators of the literacy and language development of preschool-aged children and multiple components of the home environment. The authors found a positive association between parent's demographic characteristics and children's expressive and receptive language skills. When the level of education of the parents is higher, then their children can better comprehend and express themselves verbally. This finding is not surprising considering the broad literature pointing to the comparative advantage possessed by children from middle-income homes with higher educated parents over their peers from lower income homes with less educated parents in terms of having more advanced language skills (for example, Duncan & Brooks-Gunn, 2000; Mantzicopoulos, 1997; Snow, Burns & Griffin, 1998).

Contrary to the above-mentioned research indicating positive associations between the parent's education level and child's cognitive level, there were different findings in the current study. The parents of the child participants were university educated in 4 out of 5 cases, while in one case (M-GR-L), the parents were at most high-school educated and had an immigration background. The children in the latter case had relatively higher systems thinking scores. Additionally, within this case, the distribution of the scores were relatively closer to each other. It was considered that the quality of the ECE experiences of the children may have compensated for social disparities in the development of cognitive and language competencies. The aspect of the quality of ECE serving as "great equalizer" (Linberg, Baeumer & Rossbach, 2013, p.25) will be elaborated later in this chapter. Another reason for their relatively higher performance could be that these children are bilingual, which was true for half of the children in the M-GR-L case.

5.1.3.2 Bilingualism

While the ages and the average scores of monolingual and bilingual children were almost the same, it should be noted that more than half of the parents of the bilingual children had immigration backgrounds and lower educational attainments. It is thought that the most influential factor for the relatively better performance of the bilingual children could be due to recent research claiming that "growing up with two languages enhances cognitive flexibility and the ability to use working memory as children switch between their two languages" (Galinsky & Gardner, 2017, p.7).

It was concluded that bilingual children performed better on EF tasks when the effect of language skills on the development of EF was extended. For instance, in comparison to a monolingual group, bilingual 2-year-olds displayed better inhibitory response performance (Poulin-Dubois, Blaye, Coutya & Bialystok, 2011). In a set of two (Martin-Rhee & Bialystok, 2008) and three (Bialystok & Martin, 2004) small studies comparing inhibitory control in monolingual and bilingual 4- and 5-year-olds, the bilingual sample was found to have an advantage. Another study, which involved 50 children attending a kindergarten, compared native Spanish/English bilingual students with children who only spoke English. A similar comparison was also made between the bilingual students and native English speakers who were enrolled in a Spanish or a Japanese immersion class. It was found that in comparison to both monolingual and immersion children, bilingual students performed significantly better on tests of EF, where the variables of children's age, verbal ability, and family socioeconomic status were controlled (Carlson & Meltzoff, 2008).

Another small study comparing 5-year-old monolingual and bilingual children found that the bilingual group had an advantage over the monolingual group in terms of giving faster and more accurate responses to a test of working memory (Morales, Calvo & Bialystok, 2013). In the same vein, when compared with their monolingual peers, bilingual 6- and 7-year-olds performed better on a test of working memory and inhibitory control (Calvo & Bialystok, 2014). A further study compared the EF abilities of 5- to 8-year-olds in three different groups. The first group consisted of German native speakers who are learning English as a foreign language. The second group comprised German and English bilinguals, and the third group contained German/English/another language trilinguals. This study determined that the second and the third groups had an advantage over the first group in terms of attention-shifting tasks (Poarch & van Hell, 2012). The necessity of shifting back and forth between languages for children learning multiple languages encourages them to learn how to inhibit the impulse to speak in one language when using the other language would be more appropriate, thereby exercising their EF skills.

In a previous part of the discussion chapter, the level difference of the 4- to 6-year-old preschool children in terms of different aspects of systems thinking was discussed. Additionally, potential factors related to the nature of the child (hereditary cognitive individual differences, age, and gender) and environmental factors (parent education level, raised as raising) were examined. In the next section, the educational factors that may have an effect on the systems thinking skills of young children will be elaborated.

5.1.4 Educational Factors

Bronfenbrenner (1979) postulated in his ecological theory that contextual impacts shape long-term human advancement. The indispensable impacts are the effect of current atmospheres in which the advancements emerge in the form of deeds, function, and social relations lived by the advancing individual in that current environment (Bronfenbrenner & Morris, 2006). Consistent with the advocacy of ecological theory, relevance was found in the current study between systems thinking skills of children and educational contexts they were involved in.

In the findings section of this thesis, the characteristics of the participants and the contextual description of the cases within the framework of the 57 different indicators integrated in the Sustainability and Systems Thinking Indicators Checklist were presented.

As previously explained, the nature of the child's mind and the knowledge level of the child were considered as the potential factors limiting the demonstration of the systems thinking skills of the children. Another most relevant factor could be the lack of the systems thinking approach in the educational settings of the sampled cases. The previous argument and the other potential factors that may have an effect on the systems thinking skills of children are discussed in the following sections. Since research in this field is in the early phases, the educational factors developed within the framework of the Sustainability and Systems Thinking Indicators Checklist were found to be the most relevant to systems thinking, and accordingly, the aim was to explore the key variables and their relationships regarding the young children's systems thinking skills as suggested by Yin (1994) and Eisenhardt (1989).

The findings of the current study indicated that the duration of attending a preschool, facilitating children's conflict resolution, providing children with opportunities to see and touch the systems explicitly, linking and deepening learning through project-based learning, engagement with critical thinking required in education for the sustainability paradigm, posing cognitively challenging questions, and teachers orchestrating those characteristics of the educational context could be related to the systems thinking skills of children. This study revealed that the educational contexts of the cases fell short in terms of creating learning opportunities within the systems approach. Explicit conversations on systems, closed-loop relationships, root causes, degree of impacts between causes and effects, hidden components and processes, unintended consequences, dynamisms, and complexity; in short, how systems work, were absent in the educational contexts that were observed within the framework of this thesis study.

The potential effect of educational contexts on the systems thinking skills of young children will be discussed in detail in the following part of the study.

5.1.4.1 Duration of preschool attendance

The findings section revealed that children in Germany started early childhood education earlier than their peers in Turkey. Research on the effects of preschool education on children's development has found that the duration of attending early child education and care (ECEC) is associated with a child's cognitive level (Sammons et al., 2008). Children attending the M-GR preschool were exposed to early childhood education longer than their peers in other cases. Thus, duration of preschool attendance could be one of the factors positively affecting the systems thinking skills of the M-GR-M and M-GR-L cases.

5.1.4.2 Role of the Preschool Climate

Children are affected by the social circles they encounter and live in, as in Bronfenbrenner's ecological theory (Bronfenbrenner, 1979). Thus, there is an emphasis on the climate of the preschool, because there is a possibility that it can influence the learning and development experiences of the children, and consequently their systems thinking skills. "The term 'school culture' applies to the school as a space for living, characterized by its 'climate', its relationships and its forms of participation and communication" (Transfer 21 Programme, 2007, p. 13). Adopting an approach within this framework, an attempt was made to reveal the possible effects of the preschool climate on children's systems thinking skills through six indicators. Since in the literature researchers have connected impaired problem solving in preschool children with a lack of social skills that subvert peer proficiency (Rudolph & Heller, 1997), the following indicator was considered to be particularly relevant: 'Children act out democratic forms of conflict resolution in the group. Negotiation and conflict resolution processes are fostered' because they are thought to have an effect on the systems thinking skills of children.

There have been theories and research (Buckley, 2000; Selman, 1980, 1981) that suggested that children at preschool age could not put themselves into another's shoes in a conflict situation to resolve a dispute. However, other empirical studies have disputed this view (Johnson & Johnson, 1996; Stevahn, Johnson, Johnson, Oberle & Wahl, 2000), arguing that young children can gain the main skills needed for solving conflicts. In the current study, it was also witnessed that children encounter less conflict situations in settings where negotiation and conflict resolution processes are facilitated. Moreover, it has been found that in the cases where these processes are not handled in a structural manner (M-TR and A-GR), the children exhibit a lower level of multi-dimensional perspective and perform at a lower level in problem solving when compared to the children in the other cases.

It was concluded that other indicators in this section (institutionalized participation structures, conflict resolution processes among adults, professional communication among staff, approach to staff development and training, and cooperation with others outside the preschool) can enhance the cognitive and social development systems thinking skills of preschool children by contributing to the quality of the preschool. In the context of the aforementioned indicators, it was concluded that the ECE services offered in Germany exhibit more democratic, participatory and communicatory approaches.

5.1.4.3 Role of Physical Space

This part of the thesis briefly discusses the role of the physical environment on the systems thinking skills of children. The physical possibilities of all the participating cases differ, and this has been detailed in the findings section. In the case descriptions, the size and quality of the physical environment were defined, together with the children's access levels to the outdoor and indoor environments, and the qualities of available materials in the learning environment. Indicators referring to children have time and space to use materials were also presented. There were also attempts to illustrate the existence of systems in the environment.

In the scope of this thesis, no clear relationship was discovered between the physical space in the educational context and the children's systems thinking skills. In two extreme cases in terms of physical conditions; i.e., one providing the widest physical space the children with the most free access to this area (A-GR) and the other providing the most limited space for children (M-TR), it was found that the systems thinking scores of children were very similar and relatively lower than the other cases. In all events, all the cases were able to meet the general quality standards on physical environment, such as physical environment being safe and appropriate and providing a diverse range of experiences that promote children’s learning and development (National Quality Framework, 2018). It is believed that since all cases were able to present children with a physical space with certain quality standards, there was no clear relation between physical space and systems thinking could be found.

In the physical environment of the M-GR-L case, there was a feature that is not included in other cases. The children in this case were working on living systems located in the classroom, and they were able to see and touch the systems. It is considered that this finding may indirectly contribute to the children's systems thinking skills.

As a result, although field studies exemplify that the form of the space can boost child development (Berris & Miller, 2011; Knackstredt & Wellisch, 2005), in the current study, the role of the physical space on systems thinking was not clearly revealed.

5.1.4.4 Linking and Deepening Learning through Project-Based Learning

In the current study, it was concluded that many indicators determined in advance and observed in the field can be met through deep project learning experiences. In both cases located in the M-GR preschool, learning experiences were connected to other learning experiences through detailed and long-spanned project work. It was concluded that the project work facilitated the children's ability to view time in a more horizontal and space in a more vertical way. Therefore, this part of discussion will focus on project-based learning in particular. In *Engaging Children's Minds,* Katz and Chard (2000) defined a project in the following way:

> We use the term project to refer to an in-depth study of a particular topic usually undertaken by the whole class working on subtopics in small groups, sometimes by a small group of children within a class, and occasionally by an individual child. The key feature of a project is that it is an investigation— a piece of research that involves children in seeking answers to questions they have formulated themselves or in cooperation with their teacher and that arise as their investigation proceeds (p. 2).

John Dewey was one of the leaders in positing that children can learn in an ideal manner when they design their own activities and apply those designs; thus, that instruction can be undertaken at multiple levels, learning can be attained in a cooperative way, peer support can be achieved and learning can be performed in an individual manner (Harris & Gleim, 2008). Currently, many teachers think that project-based learning may fulfil Dewey's aims (Beneke & Ostrosky, 2009; Brewer, 2010; Yuen, 2010). Overall, the project approach is viewed as empowering children because they are active participants in shaping their own learning (Harte, 2010; Helm & Katz, 2011).

There are a wide range of approaches to project based learning; however, it is accepted that authentic deep projects have some common characteristics (Helm, 2015; Katz & Chard, 1989; Martin & Baker, 2000; Thomas, 1998):

- It is child-centered, child-driven, and child-directed
- There is a definite beginning, middle, and end
- Content is meaningful to children, it is strongly connected to the children's world, and real-life problems are being dealt with
- First-hand hands-on investigation is utilized
- It enables children to experience intellectual insight and depth of thinking
- The deep project is sensory-rich with authentic artifacts; there are tangible products as outcomes that can be shared with different audience

- It is sensitive to local culture and it is culturally appropriate
- Teachers are co-learners
- Opportunity for reflective thinking and self-assessment is created
- Authentic assessment techniques (portfolios, journals, etc.) are often in use

Deep projects provoke children to think deeply, analyze, synthesize new ideas, and form substantive views, structures, and other productions (Helm, 2015). Projects involve children in a constructive investigation; in other words, the conversion and building of new information and new considerations must be involved in the project (Thomas, 2000).

Project-based instruction includes exercises that are quite dissimilar to traditional approach as follows: project-work provides more challenging, sophisticated work; it has an interdisciplinary, rather than departmentalized focus; provokes cooperative learning (Anderman & Midgley, 1998; Lumsden, 1994); and are executed in longer time frame (Challenge 2000 Multimedia Project, 1999). It is a holistic teaching strategy, rather than an add-on (Railsback, 2002). Children retain more cognitive content and gain skills when they are engaged in stimulating projects. Through projects, children utilize higher order thinking skills instead of memorizing facts in a detached context which gives no clue about how and where this information can be utilized in the real world (Blank, 1997; Bottoms & Webb, 1998). Unsurprisingly, one of the end-products of this process is increasing problem-solving skills (Moursund, Bielefeldt & Underwood, 1997) because it enables children to make and see connections (Railsback, 2002).

Considering all the indicators taken in the scope of this research, it is the project-based learning experience that utilizes multi-disciplinary, interdisciplinary, constructivist approaches, requires engagement and exploration, positioned on the child's world, expands depth of thinking, integrates complex knowledge, accepts children as active learners, and encourages children to learn collaboratively with their peers and their teachers. It is argued in this study that all those features given above are meaningful in terms of systems thinking.

There are many strategies that assist in utilizing a project-based learning approach in a qualified way, and some of these strategies were applied in the current study. Adults displayed flexibility when creating learning opportunities; in the M-GR-M and M-GR-L cases, it was concluded when determining project topics and activities within projects and shaping the process, the teachers take the children's ideas and suggestions into account. Children were able to ask questions and talk without any hesitation. Adults listened for and encouraged children's thinking. The opportunities for a circle of viewpoints were frequently created. The children were provided with the space to participate in decision-making processes in line with their age and abilities, and the adults encouraged the children to do things for themselves. Thus, it was concluded that those characteristics of the classrooms created an intellectual and social atmosphere in which there were "respectful exchanges between students and the teacher, a class assessment of what students already know, a clear vision of what they need to know to learn the material well, and the design of learning activities that are student-centered and dynamic" (Tokuhoma-Espinosa, 2010, p. 115). In that sense, the role of social and intellectual freedom, learning by doing and trying "to link what is taught in class with applications to the students' lives" (p. 116) comes to the fore. In the book "Young Investigators", Helm and Katz (2011) utilized the circular diagram by Bess-Gene Holt (1989) and Holt's concept of Distance from Self. It was argued that the more the learning experience is connected to the children's own immediate daily reality, which means to their own concept of self, the more learning outcomes will be encountered. By the use of three numbered circles, Helm (2015) (see Figure 106) demonstrated the project topics that are more likely to deeply engage children in line with their developmental levels. According to this numbering mentality, the first circle includes topics relevant to the world of the young child. The second circle (which also contains the topics in Circle 1) includes topics that are meaningful to the preschooler. The third circle (which includes everything in Circles 1 and 2) demonstrates topics relevant to the immediate world of the preschooler and first-grader. It is considered that this diagram also includes educational implications related to the systems thinking skills of young children.

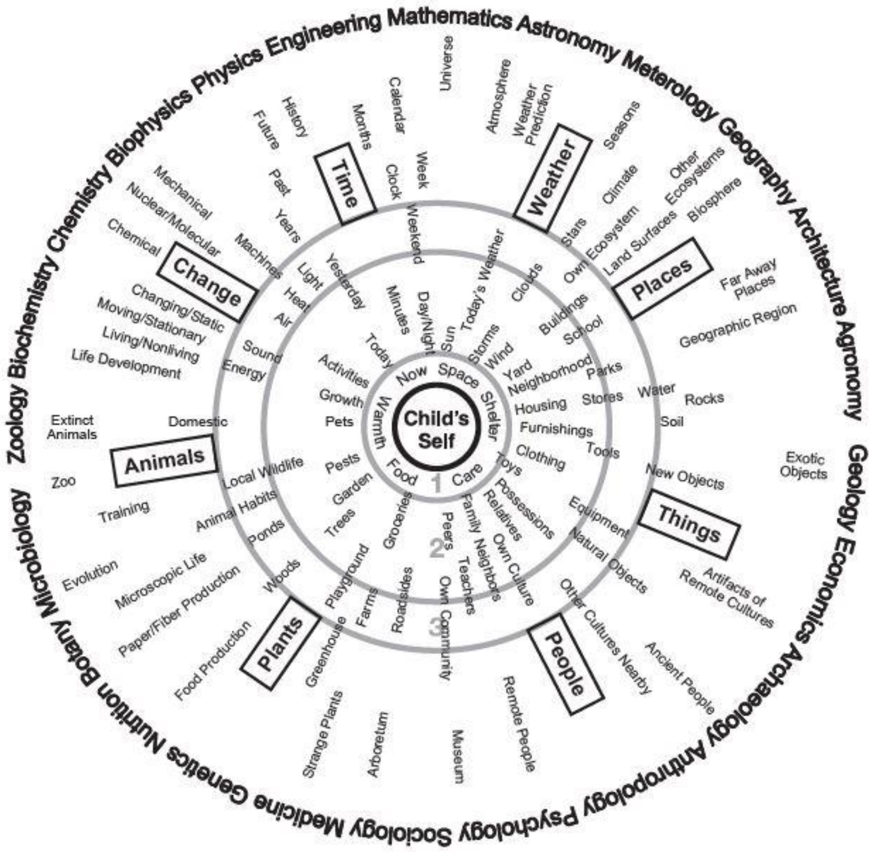

Figure 106. Distance from Self diagram (Helm, 2015, p. 51)

The other aspects of project-based learning addressed in this research were opportunity for reflective thinking and self-assessment, and utilizing authentic assessment techniques (portfolios, journals, etc.). Unlike in other cases, it was concluded that there were wrap-up or reflection exercises at the end of the projects in the M-GR-M and M-GR-L cases. Additionally, various documentation techniques were used in those cases, and that documentation allowed the children to observe their own learning processes over time. That these two indicators were fully fulfilled led to the conclusion that these techniques could have a positive impact on children's systems thinking skills. This is because children reach higher levels of thinking when they participate in documentation activities, and this "documentation contributes to children's own understanding of how they and others learn; it serves as a reminder of what goes on in the classroom, offering students an opportunity for reflection, for evaluation of other children's theories and hypotheses, and for self-assessment" (Project Zero, 2003, p. 17). Furthermore, according to Seidel (2001), documentation makes it possible for children to have a look again to their duties, deeds, and opinions and chase after them.

As children participate in documentation activities, they put their self-regulated learning and metacognition into practice (Clark, 2012; Zimmerman, 2000). When children are active participants in the documentation process, they come to learn more about their own thinking. The documentation process has the potential to help children develop and use metacognitive skills crucial for ongoing learning and development. By using the pedagogical documentation, children's thinking processes are supported so that they can “retrace their own processes, to find confirmation or negation, and to self-correct” (Rinaldi, 1998, p. 122). Again, when considered within a systems thinking perspective, a conclusion was reached that reflection and documentation exercises, which provide direction towards meta-cognition, have the potential to contribute to children's cognitive development, and help deepen their learning experiences.

As a result, it is considered that qualified project-based learning experiences may enhance the systems skills of children, because in project-based learning:

- Children’s subject-matter knowledge is widened through deep learning experiences. Children may become more knowledgeable about the obvious and hidden components and processes in the chosen issue.
- There is a possibility of exploring dynamic and interdependent relationships between components and processes in the chosen topic, as well as of reaching different levels of causal understanding through deep investigation.
- Collaborative processes may enable participants to learn and produce together. This characteristics of the project-based learning (PBL) has the potential to create multi-dimensional approach among the project participants.
- Documentation may enable learners to observe their own learning processes. This may help them to create a more holistic understanding of the issue. It may allow children to observe the dynamism throughout the process. Additionally, documentation may trigger meta-cognitive processes which will cause more meaningful and permanent learning. Also, documentation may enhance the temporal understanding of children since it allows to do some sort of “mental time travel” as termed by Suddendorf and Corballis (2007).

5.1.4.5 Connection with Sustainability

In this thesis, there is a focus on the educational context indicators that can reveal commonalities between systems thinking and sustainability. Based on the assumption that common directions can be derived from two phenomena, it is quite possible to observe that many topics from the systems window can be considered to be under the heading of sustainability. When the sustainability issues are approached from a global perspective, the interactions of economic, social and ecological systems can be discussed. Furthermore, in the issues addressed at a more local level, an eco-system, a specific social problem, or an economic structure that interacts with social issues at the local level can be discussed as a sustainability-related issue. It is believed that utilizing the system approach to issues related to sustainability, meaning the unveiling the web of relations, interdependencies, complexity, and dynamic relationships, is considered necessary for the high-leverage of interventions. It is thought that these steps are needed to produce more qualified solutions to sustainability-related problems of the system, considering that the issues discussed from different angles, approaching in a holistic and future-oriented way, and being aware of the structure under inspection is a system itself. In accordance with this statement, Wiek, Withycombe and Redman (2011) collected the central competencies in sustainability based upon a wide review of the literature and deduced that systems-thinking was one of those elements.

For these reasons, when undertaking the sampling in the research, care was paid to the preschools claiming to offer alternative education especially related to sustainability. From the outside, although it is given that sustainability is addressed in the pedagogical concepts of the preschool, throughout the engagement with the education in the A-GR case, it was concluded that no strong evidence can be associated with sustainable education in this educational context since the most important aspect of this case is the lack of educational content. Interestingly, on the contrary, in one of the mainstream cases in Germany, namely the M-GR-L case, more evidence was found that was appropriate to be evaluated under education for sustainability[44]. The A-TR case created the most qualified learning experience in harmony with the sustainability perspective. However, there was a fragmented approach in this case in that non-related learning experiences are presented to children by different adults throughout the day. As a result, the relationship which was expected to occur between utilization of education for sustainability principles and

[44] It is important to note that there is a specific section on ESD in the Berlin ECE curriculum. There is no acknowledgement of ESD in the ECE curriculum in Turkey. In addition, it was witnessed that qualified efforts on waste management have been performed in the cases in Germany. The performance of the cases in Turkey remained relatively lacking in this sense.

demonstrating higher-order systems thinking did not emerge clearly in the current study. When viewed in the context of EfS and systems thinking concepts, which are prominent in the A-TR case, it was thought that there may be a potential relationship between engagement with critical thinking and demonstrating multi-dimensional approach[45] since EfS states the necessity of thinking critically and creatively about the structuring (and possible restructuring) of didactical arrangements. As observed in the case of A-TR, both children and adults were engaged in critical thinking exercises, and it was concluded that the social, ecological and economic mainstream approaches were frequently criticized in this context, and discussions on alternative approaches toward taken-for-granted assumptions were held.

It is believed that the relationship between EfS and systems thinking can be furthered by emphasizing cultural diversity. The findings of the current study revealed that the cases in Germany had an advantage in terms of providing children with the opportunity to learn, appreciate and compare cultural diversity. The understanding of diversity was furthered through the adults' acceptance of people in their differences and the definitions of the diversity obtained from the cases from Germany. It is thought that this characteristic of the above-mentioned cases may have an effect on children's multi-dimensional thinking abilities. Since the existing literature on multicultural cognitive assessment is limited (Byrd, Arentoft, Scheiner, Westerveld & Baron, 2008), the current argument reveals more questions than answers and necessitates further evidence to support the argument. However, it is important to note that the explanation of the potential influence of being raised as bilingual on systems thinking could be revisited to build a connection between two concepts.

From the research process, the following conclusion is drawn; it is thought that education for sustainability and systems thinking concepts will have a meaningful connection with project-based learning. Although it has not clearly emerged in the current study, project-based learning, systems thinking and sustainability programs do have many common aspects (Wiek, Xiong, Brundiers & van der Leeuw, 2014). For instance, the Project-Based Learning Model created by the Pacific Education Institute adjusts systems thinking skills to sustainability issues via project-based learning approach by stating that seeing the big picture, looking for interdependencies within a system, and considering both short- and

[45] This issue was featured in the big picture thinking aspect in the first part of the discussion.

long-term consequences of actions all of which are critical for effectively dealing with the complex and interconnected issues in our environment today (Taylor, Ferguson, Tudor & Angell, 2001). In addition to providing experiential learning opportunities that are effective in all educational fields, there are several reasons that make project-based learning essential for sustainability education. The theory of sustainability is unique when compared with other disciplines as it improves choices for distinct types of sophisticated problems (Wiek, Ness, Brand, Schweizer-Ries & Farioli, 2012; Wiek & Lang, 2014). Developing solution choices for these problems requires in-depth exploration, as well as collaboration across different types of expertise. Thus, sustainability programs must equip children not only with content knowledge and analytical skills but also with interpersonal competencies and transdisciplinary work experience; thus, it is argued that these skills can be achieved through hands-on practice and teamwork.

5.1.4.6 Importance of Questions

In this research, it was concluded that systems thinking skills of the children from an educational context in which cognitively challenging questions were asked were better than the peers from other educational contexts. Evidence on the nature of the questions posed to the children were collected based on the Marion Blank's Levels of Questioning Model (Blank, Rose & Berlin, 1978). Blank determined that there were four different levels of questions used. Basic questions require simple concrete information whereas more complex questions ask for abstract information. From the perspective of the Levels of Questioning approach, it was concluded that teachers in the M-GR preschool often asked children questions at the highest level. Through these high level questions, the adults created opportunities for children to summarize, define, compare and contrast, provide judgments, make predictions, solve problems, and explain concepts. Throughout the observation period, it was observed that these processes engaged the children in high-level cognitive procedures. Since systems thinking is also assessed in the higher-order thinking category, it is deduced that high-level questions will also serve to improve systems thinking skills. As Strasser and Bresson (2017, p.6) stated, "a high-level question is always a question that each child will answer their own way, which indicates that she is using what she knows and she's learning instead of just recalling information", and they explained that these questions are developmentally appropriate for the age and stage of the individual child. A meta-analytic method was used by Redfield and Rousseau (1981) to combine experimental research findings on the relationship between the questioning level of teacher and student success. They concluded that “predominant use of higher level questions during instruction has a positive effect on student achievement” (p. 241).

When considered within the systems thinking framework, it appears that there are other implications besides invoking different questioning types on higher-order cognitive domain in educational contexts. High-level questions have the potential to deepen the learning experiences, explore complex causal relations, connect the learned material with real-life situations, provide opportunities for mindful problem solving, create the opportunity for mental time travel among past-present-future, and approach an issue at the phenomenological level. It is believed that these processes, driven by high-level questions, are essential for systems thinking. As a result, it is considered that the high-level questioning experiences created by the teachers are one of the underlying causes behind children's relatively better performances in the M-GR-M and M-GR-L cases.

5.1.4.7 Absence of Systems View in Educational Contexts

When the fulfillment level of indicators related to the systems thinking aspect handled within the current research is considered, the findings revealed that the educational contexts of the cases fell short in terms of creating learning opportunities within the systems approach. Explicit conversations on systems, closed-loop relationships, root causes, degree of impacts between causes and effects, hidden components and processes, unintended consequences, dynamisms, complexity, in short, how systems work were absent in the educational contexts visited within the framework of study of this thesis. Moreover, the adults who participated in the research had clearly stated in their interviews that they were not aware of these issues.

It is believed the lack of utilizing systems thinking approach in learning experiences could be related to the young children’s limitations in terms of systems thinking skills because research in the field demonstrates that interventional systems thinking studies had an impact on the enhancement of the children’s systems thinking. The Waters Foundation conducted action research with 197 separate studies from schools and classrooms throughout the United States at K-12 level. Given below is the evidence that the studies had an impact on the enhancement of the children’s systems thinking (Waters Foundation, n.d., p. 6-7):

- Students used systems thinking tools to clarify and visually represent their understanding of complex systems. This visual approach allowed the students to interact with and explore thoughts, perceptions, and mental models with precision and clarity.
- Systems thinking tools helped students make connections between curricular areas and relevant life experiences.
- Students of all ages learned and independently used systems thinking problem-solving strategies.
- Systems thinking concepts and tools helped students develop as readers and writers.
- When using systems thinking concepts and tools, many students showed increased motivation, engagement, and self-esteem.

5.1.4.8 The Teacher

The role of teachers should be also addressed in relation to the previously discussed indicators which are thought to have the potential to influence the systems thinking skills of children. The results of the study revealed that teachers played important roles in facilitating structural conflict resolution processes for the children, constructing deep project-based learning experiences, triggering the cognitive processes of the children through cognitively challenging questions, creating intellectual and social freedom, enabling the children to observe their own learning processes over time through wrap-up and self-reflection exercises and well-executed documentation applications, and providing children with the opportunity to learn, appreciate and compare diversity in nature and in cultures. The findings of the study showed that although the parental backgrounds differed, the children from the M-GR-M and M-GR-L cases benefited from the ECE service offered to them at similar levels. It appears that the most important factor that makes this possible is related to the possibilities offered by teachers with their professional qualifications. In the M-GR-L case, there were two teachers (one full-time and one part-time) and a teacher with language development expertise who worked with children, and this staffing level provided the necessary time and space to further expand the children's learning experiences. Yet, in this case, implementing qualified educational applications that need preparation and post operations have not escaped from the attention.

Teacher professionalism is considered as the most significant factor in education improvement (NCTAF, 1996). Also, it is stated repeatedly that equity in societies begins with effective early childhood education. Research conducted in Australia by Susan Krieg, David Curtis, Lauren Hall and Luke Westenberg (2015) stated that in higher quality preschool education programs that have improved staff expertise and are more concerned with children's activities, the children demonstrated higher acquisition in cognitive improvement than children who participated in programs of lower quality. The study also proposed that children who benefited most from attendance in these programs were from backgrounds with greater social disadvantage. Hilferty, Redmond, and Katz supported those findings by stating that "the link between high-quality childcare and positive child outcomes is especially strong for children from disadvantaged families" (2010, p.67). In that sense, the current study can be perceived as one of the examples which demonstrates the effect of the high quality ECE on diminishing the disadvantages of the young learners**.**

Dr. Gordon Brown, MIT Professor Emeritus, fully acknowledged the challenges facing educators in terms of systems thinking:

> As they [children] grow up, if they're not exposed to these broader pictures, and their education is put out piecemeal, they don't get an opportunity to realize how things interconnect. It requires the shift of mind by our teachers to pass that kind of knowledge to students, so it [systems thinking] comes naturally to them. It's part of their intuitive processes of reasoning that they will become systems thinkers and not linear thinkers...To be a teacher is to be a prophet—you are not preparing children for today's world, but for the world of the next 50-75 years—a world we can barely imagine. (Waters Foundation, n.d., p. 2).

This quote again brings the importance of teachers to the agenda in the context of building a sustainable future. The teacher's role needs to be emphasized as the most essential element in a student's learning through sustainability within formal environments that may be realized via the harmonizing influence of every teacher individually (Wals, 2006).

To conclude, the findings of the present study have shown that young children's potential in terms of demonstrating a complex understanding of systems is limited. Additionally, current educational contexts are lacking in terms of providing learning and development opportunities that aim to enhance the systems thinking skills of young learners. Understanding the current limitations on young children in developing systems thinking is important for early childhood educators, curriculum developers, teacher pre-service and in-service programs developers, and educational policy makers. Developing a different educational paradigm has the potential to enhance the systems thinking skills of young children and suggestions to this effect concerning the implications for educational practices and recommendations for further studies are presented in the following sections.

5.2 Implications for Educational Practices

As revealed in this research, young children are limited in terms of demonstrating a complex understanding of systems. In the discussion, the limitation of demonstrating the systems approach was considered to have originated due to three reasons. The first could be connected with human evolution since it favors mechanisms for dealing with the immediate surface features of problems. “The human mind grasps pictures, maps, and static relationships in a wonderfully effective way. But in systems of interacting components that change through time, the human mind is a poor simulator of behaviour” (Forrester, 1992, p. 6). To overcome this problem, there are computer programs that utilize different simulation models developed within the scope of systems dynamics discipline. Versions of these programs for children are also used. In situations where human cognition is limited, it is also possible to utilize systems thinking in an effective way using these programs when trying to propose innovative solutions to the problems of the contemporary society.

The second reason could be linked to the cognitive development level of young children. Higher-order thinking skills that can also help to demonstrate systems thinking are thought to be presented in a more qualified way as the child’s age increases. For this reason, it is predicted that the work to be done within the scope of systems thinking will produce more effective results if undertaken with older children in early childhood educational contexts.

The third reason is believed to be related to the current educational paradigm. As revealed in this study, current educational contexts are lacking in terms of providing learning and development opportunities that improve the systems thinking skills of young learners. “Education has taught static snapshots of the real world. But the world’s problems are dynamic,” writes Jay Forrester (1992, p. 6). Conventional teaching ignores the necessity of creating systems citizens. As explained in the introduction of the study, many scholars are convinced that dynamic behavior of systems can be taught and can be understood, even by very young children. There are many examples supporting this argument. The schools in the Waters Grant Project and the Waters Foundation provide valuable models of how systems learning can work. In this context, the first implication for educational practices in this research is to push for a paradigm shift from fragmental, mechanistic and reductionist educational approaches to more holistic, interactionist and multifaceted educational approaches. At the policy level, the significance of systems thinking needs to be acknowledged by policy makers, and this approach should be integrated into the ECE curriculum by considering it as one of the transversal dimensions of the educational paradigm. While this integration is being performed, the conventional fragmentalist approach needs to be put aside as mentioned above, the current educational paradigm has serious limitations in terms of creating a sustainable today and tomorrow, as described in the introduction to this study.

Another proposal in this research to be presented at the policy level is the enhancement of the structural quality of early childhood education offered to young children. This study demonstrated that the low adult-child ratio in educational contexts and exposure to different educational practitioners positively affect the children's learning and development. It is suggested that more resources should be allocated to budget items related to teachers in order to achieve this advantage.

The second component of the proposed paradigm shift considers the teacher pre-service and in-service programs. There is a meaningful relationship between the quality of learning experiences that teachers offer children and the skills they develop. As revealed in this study, early childhood education teachers were not exposed to pre- and in-service programs related to systems thinking and ESD. This situation directly affects the learning designs that the teachers prepare for the children. In this context, this research strongly suggests the integration of systems thinking into the pre- and in-service teacher training programs accompanied by a critical thinking approach toward taken-for-granted assumptions and practices. In addition, the development of teacher qualifications in the areas to be described below is thought to have positive consequences for enhancing both the education service offered to children and the systems thinking skills of the children.

Inherently, the study's most detailed implications for educational practices are presented to early childhood educators on the basis that the aim of this study was to explore the key educational context variables that may have an effect on young children’s systems thinking skills. First of all, it should be noted that this study revealed that the current educational contexts do not create learning opportunities within the systems approach. Explicit conversations on systems, closed-loop relationships, root causes, degree of impacts between causes and effects, hidden components and processes, unintended consequences, dynamisms, complexity, and in short, how systems work are absent in the educational contexts visited within the framework of the study presented in this thesis. Moreover, the adults who participated in the research had clearly stated in their interviews that they were not aware of these issues. Educational practitioners should be aware of the development of effective tools to enhance young children's systems thinking which have resulted of the research applied in this field. Behavior-over-time graphs, causal loops, connection circles, concepts maps, stock/flow maps, and computer programs including simulation models are among those tools that can be used in educational settings. As this study revealed, through a story reading, it was possible to measure systems thinking skills of young children and it is believed that this tool can also be used to enhance children's systems thinking skill. In that sense, using stories as a tool for systems thinking is highly recommended by this study. This research suggests that early childhood educators become competent in terms of utilizing the available systems thinking tools that are available for young learners.

In the findings and discussion chapters, it was determined that children who were exposed to holistic teaching strategies that embodies learning experiences which are connected to other learning experiences through detailed and long-spanned project work had better systems thinking performances. As explained in the discussion chapter, project-based instruction differs from the traditional educational approach because it provides interdisciplinary, challenging and sophisticated learning experiences which supports cooperative learning and are executed in longer time frame. Children retain more cognitive content and gain skills, such as problem-solving when they are engaged in stimulating projects, because this situation allows children to see and make connections. In that sense, this study highlights the potential of the project-based learning in terms of creating systems citizens for a sustainable world.

As explained in detail in the discussion chapter, some of the strategies that assist in utilizing a project-based learning approach in a qualified way do also have the potential to improve the systems thinking skills of the children, because those strategies improve the quality of learning and cognitive development. Accepting children as active learners, following their lead when designing learning experiences, choosing child-related project contents, enhancing children's knowledge and perspectives through an engagement in deep investigations that are designed as multidisciplinary and interdisciplinary, supporting the social and intellectual freedom of children, enabling collaborative learning, and guiding children to observe their learning experiences throughout time via documentation techniques are some of the strategies that are offered to early childhood educators through this research.

Another potential implication for early childhood educators is related to the integration of a sustainability approach into education in order to enhance the capacities of children to become system citizens. In this research, it is argued that enhancing the system approach can be effectively utilized through principles of ESD since both concepts emphasize a holistic approach, web of relations, interdependencies, complexity, dynamic relationships, and high-leverage of interventions. In addition, both concepts favor an unconventional approach toward issues by highlighting critical and creative thinking concerning the structuring (and possible restructuring) of didactical arrangements. This study underlines that working with living systems and appreciating multi-culturalism, as well as multi-lingualism may offer important opportunities for further development of the systems thinking skills of young children.

Posing high-level questions that create opportunities for children to summarize, define, compare and contrast, provide judgments, make predictions, solve problems, and explain concepts is thought to be another practical implication of this research that is presented to early childhood educators, since it was deduced that high-level questions also serve to improve systems thinking skills. As argued in the discussion chapter, high-level questions have the potential to deepen learning experiences, explore complex causal relations, connect the learned material with real-life situations, provide opportunities for mindful problem solving, create the opportunity for mental time travel among past-present-future, and approach an issue at the phenomenological level.

To conclude, in this section, implications for educational practices were addressed parallel to the findings of this study. Based on these points, recommendations for further research are presented in the following section.

5.3 Recommendations for Further Research Studies

The goal of this doctoral research project was to explore the nature of systems thinking skills of 4- to 6-year-old preschool children and investigate the key educational contextual variables that may have an impact on those skills from a comparative perspective existent in the Turkish and German educational contexts. The findings of the study have been discussed and implications for educational practices have been provided, and in this section, some recommendations for related further research studies are addressed. The initial recommendations are related to the sampling strategies. First, the current study could be replicated with a larger sample. Moreover, as convenient sampling was utilized in this study, other studies could be conducted with random selection of the sample to ensure that the sample represents the selected countries. In this research, because of the relation of systems thinking with the executive function of the brain, it was concluded that a higher quality of work could be performed with children aged six years, hence working with oldest learning groups in preschools is the first recommendation for further studies. Even though this study did not provide evidence regarding the effect of the gender on the systems thinking skills of children, repetition of the study with boys and girls through a longitudinal study may provide some implications for educational practices. In addition, the same study can be replicated comparatively with children who have mono-lingual vs. bilingual backgrounds, as well as with children from different parental backgrounds to explain the key factors in terms of the nature and nurture of the child. Undertaking cognitive level segmentation and language development segmentation while sampling is another recommendation for researchers in this field. Adding observation component as a measurement tool to conceptualize the young children's systems thinking skills is another recommendation for further research studies due to the late development of the expressive language of the children of the targeted age group. In this research, the selected theme was water because it is an essential resource for every living thing. As revealed in the survey, the children's subject-matter knowledge about the behavior of water in nature is limited. In this context, it is suggested that future researchers replace this topic with an adapted version of the rubric produced in this research with a theme about which the child participants have very detailed and comprehensive subject-matter knowledge.

In order to further explore the potential key variables that have an impact on systems thinking skills of young children, replicating the study in various educational contexts within comparative approach is strongly suggested. In this sense, working with preschools that have the most different pedagogical approaches as possible has emerged as a necessary step to further the conclusions of this study. Especially in educational contexts where project-based learning is utilized in the scope of ESD, replicating this study is thought to result in important consequences in terms of revealing key variables in those educational contexts concerning systems thinking. The final suggestion is to focus on investigating extreme cases as much as possible in terms of the physical possibilities in order to shed light on the relationship between the variables related to physical space and systems thinking.

This study has argued that a more comprehensive understanding regarding the factors existent in educational contexts that have an impact on systems thinking skills of young children may help to fill the gaps both in theory and practice, and remove the barriers in terms of achieving a more sustainable future for current and future generations.

REFERENCES

Ackerman, D. J., & Friedman-Krauss, A. H. (2017). Preschoolers' executive function: importance, contributors, research needs and assessment options. *ETS Research Report Series*, *1*, 1-24.

Ackoff, R. L. (1981). *Creating the corporate future: Plan or be planned for*. New York: Wiley.

Ackoff, R. L. (1999*). Rethinking the fifth discipline: Learning within the unknowable.* London: Routledge.

Åkerman, E. (2012). *Children's systems telling and the story of meatball's social-ecological system* (Unpublished master's thesis). Stockholm University.

Alexander, P. A., Murphy, P. K., & Kulikowich, J. M. (1998). What responses to domain specific analogy problems reveal about emerging competence: A new perspective on an old acquaintance. *Journal of Educational Psychology, 90,* 397-406.

Alkis, S. (2008). Education for sustainable development in Turkey. *International Schulbuchforschung*, *30*(2), 597–608.

Anderman, L. H., & Midgley, C. (1998). *Motivation and middle school students.* Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education. (ERIC Document Reproduction Service No. ED421281).

Anderson, V., & Johnson, L. (1997). *Systems thinking basics: From concepts to causal loops.* Cambridge: Pegasus Communications.

Anderson, P. J., & Reidy, N. (2012). Assessing executive function in preschoolers. *Neuropsychological Review*, *22*, 345–360.

Andersson, B. (1986). The experiential gestalt of causation: A common core to pupils' preconceptions in science. *European Journal of Science Education, 8*(2), 155-171.

Andrews, G. & Halford, G.S. (2002). A cognitive complexity metric applied to cognitive development. *Cognitive Psychology, 45*, 153-219.

Archick, K. (2017). *The European Union: Current challenges and future prospects*. Retrieved from https://fas.org/sgp/crs/row/R44249.pdf

Ardila, A., Rosselli, M., Matute, E., & Guajardo, S. (2005). The influence of parents' educational level on the development of executive functions. *Developmental Neuropsychology, 28,* 539–560.

Arnold, R. D., & Wade, J. P. (2015). A definition of systems thinking: A systems approach. *Procedia Computer Science, 44*, 669–678.

Atance, C. M., & Jackson, L. K. (2009). The development and coherence of future-oriented behaviors during the preschool years. *Journal of Experimental Child Psychology, 102,* 379–391.

Banathy, B. H. (1991). *Systems design of education: A journey to create the future*. Englewood Cliffs, NJ: Educational Technology Publication.

Base, G. (2001). *The water hole.* New York: Harry N. Abrams, Inc.

Barman, C. R., & Mayer, D. A. (1994). An analysis of high school students' concepts & textbook presentations of food chains and food webs. *The American Biology Teacher, 56*(3), 160-163.

Barman, C. R., Griffiths, A. K., & Okebukola, P. A. O. (1995). High school students' concepts regarding food chains and food webs: A multinational study. *International Journal of Science Education, 17*(6), 775-782.

Barth, M., Godemann, J., Rieckmann, M., & Stoltenberg, U. (2007). Developing key competencies for sustainable development in higher education. *International Journal of Sustainability in Higher Education*, *8*(4), 416–430.

Barth, M., & Thomas, I. (2012). Synthesising case-study research – ready for the next step? *Environmental Education Research, 18*(6), 751-764.

Bausch, K. C. (2001). *The emerging consensus in social systems theory*. New York: Kluwer Academic/Plenum Publishers.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*(4), 544–559.

Bekman, S. (2005). Early childhood education in Turkey: A overview. In O. N. Saracho, & B. Spodek, (Eds.), *International Perspectives on Research in Early Childhood Education*, (pp. 335-353). USA: Information Age Publishing Inc.

Bell-Basca, B., Grotzer, T. A., Donis, K., & Shaw, S. (2000, April-May). *Using domino and relational causality to analyze ecosystems: Realizing that what goes around comes around*. Paper presented at the Annual Conference of the National Association of Research in Science Teaching, New Orleans, Louisiana.

Beneke, S., & Ostrosky, M. (2009). Teachers' views of the efficacy of incorporating the project approach into classroom practice with diverse learners. *Early Childhood Research and Practice*. Retrieved September from http://ecrp.uiuc.edu/v11n1/ostrosky.html

Benson, T. A. (2007). *Developing a systems thinking capacity in learners of all ages.* Retrieved from http://www.watersfoundation.org/webed/library/articles/Developing-STcapacity.pdf

Benson, T., LaVigne, A., & Marlin, S. (2015). *Developing understanding of dynamic systems within early childhood settings.* Paper presented at the 33rd International Conference of the System Dynamics Society, Cambridge, Massachusetts.

Ben-Zvi-Assaraf, O., & Orion, N. (2005a). A study of junior high students' perceptions of the water cycle. *Journal of Geological Education, 53*(4), 366-373.

Ben-Zvi-Assaraf, O., & Orion, N. (2005b). Development of system thinking skills in the context of earth system education. *Journal of Research in Science Teaching, 42*(5), 518-560.

Ben-Zvi-Assaraf, O., & Orion, N. (2009). System thinking skills at the elementary school. *Journal of Research in Science Teaching, 47*(5), 540–563.

Ben-Zvi-Assaraf, O., & Orion, N. (2010a). Four case studies, six years later: Developing system thinking skills in junior high school and sustaining them over time. *Journal of Research in Science Teaching, 47*, 1253–1280.

Ben-Zvi-Assaraf, O., & Orion, N. (2010b). System thinking skills at the elementary school level. *Journal of Research in Science Teaching, 47,* 540-563.

Bernard, H. R. (1994). *Research methods in anthropology: Qualitative and quantitative approaches* (2nd ed.). Walnut Creek, CA: AltaMira Press.

Berris, R., & Miller, E. (2011). How design of the physical environment impacts early learning: Educators and parents perspectives. *Australasian Journal of Early Childhood, 36*(4), 1-17.

Bialystok, E., & Martin, M. (2004). Attention and inhibition in bilingual children: Evidence from the Dimensional Change Card Sort task. *Developmental Science, 7*, 325–339.

Biklen, B. (1992*). Qualitative research for education: An introduction to theory and methods* (2nd ed.). Boston, Mass: Allyn and Bacon.

Blair, C., & Ursache, A. (2011). A bidirectional model of executive functions and self-regulation. In K. D. Vohs, & R. F. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (2nd ed., pp. 300–320). New York, NY: Guilford Press.

Blank, M., Rose, S. A., & Berlin, L. J. (1978). *The language of learning: the preschool years.* New York: Grune and Stratton.

Blank, W. (1997). Authentic instruction. In W. E. Blank, & S. Harwell (Eds.), *Promising practices for connecting high school to the real world* (pp. 15-21).

Bloomberg, L. D., & Volpe, M. (2012). *Completing your qualitative dissertation: A road map from beginning to end* (2nd ed.). Thousand Oaks, CA: Sage Publications.

BNE-BW. (2018). Umgang mit Komplexität – Systemisches Lernen. Modul 4. Retrieved from www.bne-bw.de/fileadmin/.../Modul_4_Nachhaltigkeit_lernen.pdf

BNE-Portal (2017). Education for sustainable development in Germany. Retrieved from http://www.bne-portal.de/en/education-sustainable-development-germany

Boardman, J., & Sauser, B. (2008). *Systems thinking: Coping with 21st century problems.* Taylor and Francis/CRC Press.

Bogdan, R.C., & Biklen, S. K. (2006). *Qualitative research for education: An introductory to theory and methods (5th ed.).* Needham Heights, MA: Allyn and Bacon.

Bollmann-Zuberbühler, B., Frischknecht-Tobler, U., Kunz, P., Nagel, U., & Wilhelm Hamiti, S. (2010). *Systemdenken fördern. Systemtraining und Unterrichtsreihen zum vernetzten Denken*. Bern: Schulverlag.

Bonnett, M. (2002). Education for sustainability as a frame of mind. *Environmental Education Research, 8*(1), 9–20.

Bormann, I., Heger, R-J., Manthey, H., Schmalz, A., & Wurthmann, A. (2004). *Schulische Indikatoren für nachhaltigkeitsaudit (SINA)*. Berlin: Verein zur Förderung der Ökologie im Bildungsbereich.

Bosch, O., Maani, K., & Smith, C. (2007). Systems thinking - language of complexity for scientists and managers. In S. Harrison, A. Bosch, & J. Herbohn (Eds.). *Paper presented at the International Conference on Improving the Triple Bottom Line Returns from Small-Scale Forestry*, Australia: The University of Queensland.

Bosh, O. J. H., King, C. A., Herbohn, J. L., Russel, I. W., & Smith, C. S. (2007). Getting the big picture in natural resource management—systems thinking as 'method' for scientists, policy makers, and other stakeholders. *Systems Research and Behavioral Science, 24*, 217–232.

Bottoms, G., & Webb, L. D. (1998). Connecting the curriculum to "real life." Breaking ranks: Making it happen. Reston, VA: National Association of Secondary School Principals. (ERIC Document Reproduction Service No. ED434413).

Brandstädter, K., Harms, U., & Großschedl, J. (2012). Assessing system thinking through different concept-mapping practices. *International Journal of Science Education, 34*(14), 2147-2170.

Brazelton, T. B. (1992). *Touchpoints: Your child's emotional and behavioral development*.

Breiting, S., Mayer, M., & Mogensen, F. (2005). *Qualitätskriterien für BNE-schulen. Bildung für nachhaltige entwicklung in schulen – leitfaden zur entwicklung von qualitätskriterien.* Vienna: Bundesministerium für Bildung, Wissenschaft und Kultur Ref.

Brewer, R. A. (2010). The Canada Goose Project: A first project with children under 3. *Early Childhood Research & Practice, 12*(1). Retrieved from http://ecrp.uiuc.edu/v12n1/brewer.html

Brinkman, F., & Boschhuizen, R. (1989). Preinstructional ideas in biology: A survey in relation to different research methods on health and energy. In M. T. Voorbach, & L. G. M. Prick (Eds.). *Teacher Education 5: Research and Developments in Teacher Education in the Netherlands* (pp. 75-90). London: Taylor and Francis.

Bronfenbrenner, U. (1979). *The ecology of human development.* Cambridge, Mass.: Harvard University Press.

Bronfenbrenner, U., & Morris, P. A. (2006). The bioecological model of human development. In R. M. Lerner, & W. Damon (Eds.), *Handbook of child psychology: Theoretical models of human development* (pp. 793-828). Hoboken, NJ, US: John Wiley & Sons, Inc.

Brown, A. L. (1989). Analogical learning and transfer: What develops? In S. Vosniadou, & A. Ortony (Eds.), *Similarity and Analogical Reasoning* (pp. 369-412). Cambridge, England: Cambridge University Press.

Bryar, R. M. (2000). An examination of the case study research. *Nurse Researcher, 7*(2), 61-79.

Buckley, M. (2000). Cognitive-developmental considerations in violence prevention and intervention. *Professional School Counseling, 4,* 60-70.

Bundesministerium für Umwelt, Naturschutz und Reaktorensicherheit (BMUNR) (1992). *Umweltpolitik. Agenda 21* [Enviornmental Policy. Agenda 21]. Bonn: Köllen.

Bullock, M., Gelman, R., & Baillargeon, R. (1982). The development of causal reasoning. In W. J. Friedman (Ed.), *The developmental psychology of time* (pp. 209–254). New York: Academic Press.

Burgess, R. G. (1984). *In the field: An introduction to field research.* London, England: Routledge.

Burns N., & Grove, S. K. (1997). *The practice of nursing research: conduct, critique and utilization* (3rd ed.). Philadelphia: WB Saunders Company.

Burns, M. (2000). *About teaching mathematics - a K-8 resource.* California: Math Solutions Publications.

Burns, N. R., Nettelbeck, T., & McPherson, J. (2009). Attention and intelligence: A factor analytic study. *Journal of Individual Differences, 30*, 44-57.

Busby, J., & Suddendorf, T. (2005) Recalling yesterday and predicting tomorrow. *Cognitive Development, 20*, 362–372.

Byrd, D., Arentoft, A., Scheiner, D., Westerveld, M., & Baron, I. S. (2008). State of multicultural neuropsychological assessment in children: Current research issues. *Neuropsychological Review, 18,* 214-222.

Cabrera, D., Colosi, L., & Lobdell, C. (2008). Systems thinking. *Evaluation and Program Planning, 31*(3), 299–310.

Calvo, A., & Bialystok, E. (2014). Independent effects of bilingualism and socioeconomic status on language ability and executive functioning. *Cognition, 130*, 278–288.

Capra, F. (1996). *The web of life: A new scientific understanding of living systems.* Harper Collins: London.

Capra, F. (2003). *The hidden connections: A science for sustainable living.* London: Flamingo.

Carlson, S. M., & Meltzoff, A. N. (2008). Bilingual experience and executive functioning in young children. *Developmental Science, 11*, 282–298.

Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development, 72,* 1032–1053.

Carlson, S. M., Moses, L. J., & Claxton, L. J. (2004). Individual difference in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology, 87*, 299–319.

Cartwright, K. B. (2012). Insights from cognitive neuroscience: The importance of executive function for early reading development and education. *Early Education and Development, 23*, 24–36.

Causal Patterns in Science Project. (n.d.). *A professional development resource created by the Harvard Graduate School of Education.* Retrieved April 17, 2018, from https://www.cfa.harvard.edu/smg/Website/UCP/

Center for Ecoliteracy (n.d.). *Systems thinking.* Retrieved May 17, 2017, from http://www.ecoliteracy.org/article/systems-thinking

Center on the Developing Child at Harvard University (2011). *Building the brain's "air traffic control" system: How early experiences shape the development of executive function* (Working Paper No. 11). Cambridge, MA: Author.

Center on the Developing Child at Harvard University (n.d.). *Brain architecture.* Retrieved June 6, 2018 from https://developingchild.harvard.edu/science/key-concepts/brain-architecture/

Challenge 2000 Multimedia Project. (1999). *Why do project based learning?* San Mateo, CA: San Mateo County Office of Education.

Chawla, L. (1998). Significant life experiences revisited: A review of research on sources of environmental sensitivity. *Environmental Education Research*, *4*(4), 369-382.

Checkland, P. (1999). *Systems thinking, systems practice: Includes a 30 year retrospective.* Chichester, UK: Wiley.

Checkland, P. (1981). *Systems thinking, systems practice.* New York: Wiley.

Checkland, P. (1992). Systems and scholarship: The need to do better. *Journal of the Operational Research Society*, *43*(11), 1023-1030.

Checkland, P., & Scholes, J. (1990). *Soft systems methodology in action.* New York: Wiley.

Chi, M. T. H. (2000). *Misunderstanding emergent processes as causal*. Paper presented at the *American Educational Research Association*, Atlanta, GA.

Cilli, P. (1998). *Complexity and postmodernism: Understanding complex systems.* London, England: Routledge.

Clark, I. (2012). Formative assessment: Assessment is for self-regulated learning. *Educational Psychology Review, 24*, 205–249.

Clayton, A. M., & Radcliffe, N. J. (1996). *Sustainability: a systems approach*. London: Earthscan.

Clemson, D., & Clemson, W. (1994). *Mathematics in the early years*. London: Routledge.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed). London, England: Routledge.

Cohen, R., Eylon, B., & Ganiel, U. (1983). Potential difference and current in simple electric circuits: A study of students' concepts. *American Journal of Physics, 51*, 407-412.

Conrad, C., Neumann, A., Haworth, J. G., & Scott, P. (1993). *Qualitative research in higher education: Experiencing alternative perspective and approaches.* Needham Heights, MA: Ginn Press.

Corcoran, P. B., Walker, K. E., & Wals, A. E. J. (2004). Case studies, make-your-case studies, and case stories: A critique of case-study methodology in sustainability in higher education. *Environmental Education Research, 10*(1), 7-21.

Creswell, J. W. (1995). *Research design: Qualitative and quantitative approaches.* Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five designs.* Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (2nd ed.). Upper Saddle River, NJ: Pearson Education.

Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches.* Thousand Oaks, CA: Sage Publications.

Cuevas, K., Hubble, M., & Bell, M. A. (2012). Early childhood predictors of post-kindergarten executive function: Behavior, parent report, and psychophysiology. *Early Education and Development, 23*, 59–73.

Çelik, M., & Gündoğdu, K. (2007). Türkiye'de okul öncesi eğitimin tarihsel gelişimi. *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi, 16*, 172-190.

Daellenbach, H. G. (1994). *Systems and decision making. A management science approach.* Chichester: Wiley.

Danish, J. A., Peppler, K., & Phelps, D. (2011). *BeeSign: Designing to support mediated group inquiry of complex science by early elementary students (AERA).* Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.

Davis, J. M. (2009). Revealing the research 'hole' of early childhood education for sustainability: A preliminary survey of the literature. *Environmental Education Research, 15*(2), 227-241.

Davis, J. M., & Gibson, M. (2006). Embracing complexity: creating cultural change through education for sustainability. *International Journal of Knowledge, Culture and Change Management, 6*(2), 93-102.

Davis, J., & Elliott, S. (Eds.). 2014. *Research in early childhood education for sustainability: International perspectives and provocations*. London: Routledge.

de Haan, G. (2010). The development of ESD-related competencies in supportive institutional frameworks. *International Review of Education, 56*(2), 315–328.

Delauzun, F., & Mollona, E. (1999). Introducing system dynamics to BBC World Service: An insider perspective. *Journal of the Operational Research Society, 50*(4), 364-371.

Denzin, N. K. (1970). *The research act: A theoretical introduction to sociological methods.* New York: Aldine Publishing Company.

Denzin, N. K. (1989). *Interpretive interactionism.* Newbury Park, CA: Sage Publications.

Diamond, A. (2002). Normal development of prefrontal cortex from birth to young adulthood: Cognitive functions, anatomy, and biochemistry. In D. T. Stuss, & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 466–503). London, England: Oxford University Press.

Diamond, J. M. (2005). *Collapse: How societies chose to fail or succeed.* New York: Viking Press.

Dillon, J., & Reid, A. (2004). Issues in case-study methodology in investigating environmental and sustainability issues in higher education: towards a problem-based approach? *Environmental Education Research, 10*(1), 23-37.

Dorner, D. (1989). *The logic of failure.* New York: Metropolitan Books.

Doyle, J., Radzicki, M., & Trees, S. (1998). *Measuring changes in mental models of dynamic systems: An exploratory study.* Paper presented at the 16th International Conference of the System Dynamics Society, Quebec City, Canada.

Duncan, G. J., & Brooks-Gunn, J. (2000) Family poverty, welfare reform, and child development. *Child Development, 71*, 188–196.

Eckstein, M. A. (1983). The comparative mind. *Comparative Education Review, 27*(3), 311-322. ed.). London: RotledgeFalmer.

Ecosystems Rubric of Causal Patterns in Science Project (n.d.). *The ecosystems rubric created by the Harvard Graduate School of Education.* Retrieved on April, 17 2016, from http://causalpatterns.org/pdfs/ecosystems_rubric.pdf

Edson, M. C. (2012). A complex adaptive systems view of resilience in a project team. *Systems Research and Behavioral Science, 29*(5), 499–519.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 25-32.

English, L. D. (1998). Reasoning by analogy in solving comparison problems. *Mathematical Cognition, 4*(2), 125-146.

English, L. D. (2004). Mathematical and analogical reasoning in early childhood. In D. Lyn (Ed.), *Mathematical and Analogical Reasoning of Young Learners* (pp. 1–22). Mahwah, N.J.: Lawrence Erlbaum Associates

Entwise, D. R., & Alexander, K. L. (1996). Family type and children's growth in reading and math over the primary grades. *Journal of Marriage and the Family, 58*, 341–355.

European Commission (2014). *Key data on early childhood education and care in Europe. Eurydice and Eurostat Report.* Luxembourg: Publications Office of the European Union.

European Parliament (2013). *Quality in early childhood education and care. Annex report country & case studies.* Retrieved from http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/495867/IPOL-CULT_ET(2013)495867(ANN01)_EN.pdf

Evagorou, M., Korfiatis, K. J., Nicolaou, C. Th., & Constantinou, C. P. (2009). An investigation of the potential of interactive simulations for developing system thinking skills in elementary school: A case study with fifth-graders and sixth-graders. *International Journal of Science Education, 31*(5), 655–674.

Evans, S., Banerjee, S., Huxley, P.J., & Leese, M. (2007). The Impact of Mental Illness on Quality of Life: A Comparison of Severe Mental Illness, Common Mental Disorder and Healthy Population Samples. *Quality of Life Research, 16*, 17-29.

Ezrine, G. A. (2010). *Effects of language on the development of executive functions in preschool children* (Unpublished doctoral dissertation). Georgia State University, Atlanta, GA.

Fazey, I. (2010). Resilience and higher order thinking. *Ecology and Society, 15*(3), 9.

Federal Ministry of Education and Research in Germany. (n.d.). *The organizational chart.* Retrieved March, 18, 2018 from https://www.bmbf.de/pub/orgplan_eng.pdf

Feeney, S. M., & Stiles, J. (1996). Spatial analysis: An examination of preschoolers' perception and construction of geometric patterns. *Developmental Psychology, 32,* 933–941.

Feltovich, P. J., Coulsen, R. L., Spiro, R. J., & Dawson-Saunders, B. K. (1992). Knowledge application and transfer for complex tasks in ill-structured domains: Implications for instruction and testing in biomedicine. In D. Evans, & V. L. Patel (Eds.), *Advanced models of cognition for medical training and practice* (pp. 213-244). Berlin: Springer-Verlag.

Feriver, Ş. (2010). *Integrating sustainability into early childhood education through in-service training: An effort towards transformative learning.* Unpublished master's thesis, Middle East Technical University.

Feriver, Ş., Teksöz, G., Olgan, R., & Reid, A. (2016). Training early childhood teachers for sustainability: towards a 'learning experience of a different kind'. *Environmental Education Research, 22*(5), 717-746.

Fien, J., & Tilbury, D. (2002). The global challenge of sustainability. In D. Tilbury, R. Stevenson, J. Fien, & D. Schreuder (Eds.), *Education and sustainability: Responding to the global challenge.* Cambridge: IUCN.

Fischer, J., Gardner, T. A., & Bennett, E. M. (2015). Advancing sustainability through mainstreaming a social-ecological systems perspective. *Current Opinion in Environmental Sustainability, 14*, 144–149.

Fischer, J., Hartel, T., & Kuemmerle, T. (2012). Conservation policy in traditional farming landscapes. *Conservation Letters, 5*(3), 167–175.

Friedman, W. J. (2004). The development of a differentiated sense of the past and the future. *Advances in Child Development and Behavior, 31*, 229–269.

Flood, R. L. (1999). *Rethinking the fifth discipline: Learning within the unknowable.* London: Routlegde.

Flood, R. L. (2001). The relationship of 'systems thinking' to action research. In P. Reason, & H. Bradbury (Eds.), *Handbook of Action Research: Participative Inquiry and Practice.* London: Sage Publications.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry, 12*(2), 219-245.

Forrester, J. W. (1992). *System dynamics and learner-centered-learning in kindergarten through 12th grade education.* Road Map Series Paper (D-4434-1), Massachusetts Institute of Technology.

Forrester, J. W. (2007a). Systems dynamics – a personal view of the first fifty years. *System Dynamics Review, 23*(2-3), 345–358.

Forrester, J. W. (2007b). Systems dynamics – the next fifty years. *System Dynamics Review, 23*(2-3), 359–370.

Forrester, J. W. (2008). Learning through system dynamics as preparation for the 21st century. *The Systems Thinker*, *19*(8), 2-6.

Fuhs, M. W., & Day, J. D. (2011). Verbal ability and executive functioning development in preschoolers at Head Start. *Developmental Psychology*, *47*, 404–416.

Fuhs, M. W., Farran, D. C., & Nesbitt, K. T. (2013). Preschool classroom processes as predictors of children's cognitive self-regulation skills development. *School Psychology Quarterly, 28,* 347–359.

Galinsky, E., & Gardner, N. (2017). Good guidance: The 7 essential life skills-Skill 5: critical thinking. *Teaching Young Children, 10*(2), 5-7.

Gentner, D. (1988). Metaphor as structure mapping: The relational shift. *Child Development, 59*(1), 47-59.

Gentner, D., & Rattermann, M. J. (1991). Language and the career of similarity. In A. Gelman & J. P. Byrnes (Eds.), *Perspectives on thought and language: Interrelations* *in development* (pp. 225–277). London: Cambridge University Press.

Gentner, D., Holyoak, K. J., & Kokinov, B. N. (Eds.). (2001). *The analogical mind: Perspective from cognitive science*. Cambridge, MA: MIT Press.

Gibson, R., & Fox, M. (2013). *Simple, complex and wicked problems*. Retrieved from http://mofox.com/pdf/simple,complex,wicked.pdf

Gillmeister, K. M. (2017). *Development of early conceptions in systems thinking in an environmental context: An exploratory study of preschool students' understanding of stocks & flows, behavior over time and feedback*. (Unpublished doctoral thesis). State University of New York at Buffalo.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Hawthorne, New York: Aldine Publishing Company.

Glesne, C., & Peshkin, A. (1992). *Becoming qualitative researchers: An introduction*. White Plains, New York: Longman.

Global Footprint Network. (2007). *Ecological Footprint: Overview*. Retrieved from http://www.footprintnetwork.org/en/index.php/GFN/page/footprint_basics_overview

Goerner, S. J. (2007). Today's Copernican flip: How putting collaborative learning at the hub of human evolution improves our chances of survival. *Systems Research and Behavioral Science, 24*(5), 481–491.

Gopnik, A., & Graf, P. (1988). Knowing how you know: Young children's ability to identify and remember the sources of their beliefs. *Child Development, 59*, 1366–1371.

Goswami, U. (1992). *Analogical reasoning in children.* Hove, UK: Lawrence Erlbaum Associates.

Grant, W. E. (1998). Ecology and natural resource management: Reflections from a systems perspective. *Ecological Modelling, 108*(1-3), 67–76.

Green, D.W. (1997). Explaining and envisaging an ecological phenomenon. *British Journal of Psychology, 88,* 199-217.

Greenberg, J. (2018). Teaching children to think: Meeting the demands of the 21st century. Retrieved from http://www.hanen.org/Helpful-Info/Articles/Teaching-Children-to-

Think--Meeting-the-demands-of.aspx

Griffin, P. & Robertson, P. (2014). Writing assessment rubrics. In P. Griffin (Ed.), *Assessment for Teaching* (pp. 125-155). Melbourne: Cambridge University Press.

Griffiths, D. (2004). *Introduction to quantum mechanics* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Grotzer, T. A. (1989). *Can children learn to understand complex causal relationships?*: *A pilot study.* Unpublished manuscript, Harvard University, Cambridge, MA.

Grotzer, T. A. (1993). *Children's understanding of complex causal relationships in natural systems* (Unpublished doctoral dissertation). Cambridge, MA: Harvard University.

Grotzer, T. A., & Basca, B. B. (2003). How does grasping the underlying causal structures of ecosystems impact students' understanding? *Journal of Biological Education, 38*(1), 16–29.

Guba, E. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Technology Research and Development, 29*(2), 75-91.

Gunderson, L. H., & Holling, C. S. (Eds.). (2002). *Panarchy: Understanding transformations in human and natural systems.* Washington, DC: Island Press.

Gustafsson, J. (2017). Single case studies vs. multiple case studies: A comparative study. *Academy of Business, Engineering and Science, Halmstad University, Halmstad, Sweden.*

Haddad, L. (2008). For a specific dignity of ECE: Policy and research issues relating the education of young children and sustainable society. In I. Pramling Samuelsson, & Y. Kaga (Eds.), *The contribution of early childhood education for a sustainable society* (pp. 31-36). Paris: UNESCO.

Haines, S. G. (2000). *The complete guide to systems thinking & learning.* MA, USA: HRD Press.

Haktanır, G., Güler, T., & Kahriman Öztürk, D. (2016). Education for sustainable development in Turkey. In J. Siraj-Blatchford, C. Mogharreban, & E. Park (Eds.), *International Research on Education for Sustainable Development in Early Childhood* (pp. 139-153). Switzerland: Springer International Publishing.

Hamel, J., Dufour, S., & Fortin, D. (1993). *Case Study Methods.* London: Sage Publications.

Hammond, D. (2003). *The science of synthesis: Exploring the social implications of general systems theory*. Boulder: University Press of Colorado.

Hannon, B., & Ruth, M. (2000). *Dynamic modeling.* New York, USA: Springer.

Hansen, J., Sato, M., Hearty, P., Ruedy, R., Kelley, M., Masson-Delmotte, V., Russell, G., Tselioudis, G., Cao, J., Rignot, E., Velicogna, I., Tormey, B., Donovan, B., Kandiano, E., von Schuckmann, K., Kharecha, P., Legrande, A.N., Bauer, M. and Lo, K.W. (2015). Ice melt, sea level rise and superstorms: Evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming is highly dangerous. *Atmospheric Chemistry and Physics Discussions, 15*(14), 20059-20179.

Hanushek, E., Rivkin, S. G., & Kain, J. F. (2005). Teachers, students, and academic achievement. *Econometrica, 73*(2), 417-458.

Harris, K. I., & Gleim, L. (2008). The light fantastic: Making learning visible for all children through the project approach. *Young Exceptional Children, 11*(3), 27–40.

Harte, H.A. (2010). The project approach: A strategy for inclusive classrooms. *Young Exceptional Children, 13*(3), 15–27.

Hatch, J. A. (2002). *Doing qualitative research in education settings.* Albany, New York: The State University of New York Press.

Hatch, M. J., & Yanow, D. (2003). Organization theory as an interpretive science. In H. Tsoukas, & C. Knudsen (Eds.), *The Oxford handbook of organization theory* (pp. 63-87). Oxford, UK: Oxford University Press.

Hays, P. A. (2004). Case study research. In K. deMarrais, & S. D. Lapan (Eds.). *Foundations for research: Methods of inquiry in education and the social sciences* (pp. 217-234). Mahwah, NJ: Lawrence Erlbaum Associates.

Heddens, J. W., & Speer, W. R. (2001). *Today's mathematics concepts and classroom methods.* New York: John Wiley & Sons.

Heinämäki, L. (2008). *Early childhood education in Finland.* Occasional Paper 39. Berlin: Liberales Institut. Retrieved from http://pro-kopf.de/fileadmin/Downloads/OC_39-Heinaemaeki-ECE_in_Finland.pdf

Heinrich Böll Stiftung (2017). What are the main challenges facing the European Union in 2017? Retrieved from https://eu.boell.org/sites/default/files/boll_event_report_challenges_eu_2017.pdf

Held, D., McGrew, A. G., Goldblatt, D., & Perraton, J. (1999). *Global transformations: Politics, economics and culture.* Stanford, California: Stanford University Press.

Helm, J. H. (2015). *Becoming young thinkers: Deep project work in the classroom*. New York: Teachers College, Columbia University.

Helm, J. H., & Katz, L. G. (2011). *Young investigators: The project approach in the early years* (2nd ed.). New York, NY: Teachers College Press.

Henning, P. B., & Chen, W. C. (2012). Systems thinking: Common ground or untapped territory? *Systems Research and Behavioral Science, 29*(5), 470–483.

Hilferty, F., Redmond, G., & Katz, L. (2010). The implications of poverty on children's readiness to learn. *Australasian Journal of Early Childhood, 35*(4), 63-71.

Hipkins, R., Bull, A., & Joyce, C. (2008). The interplay of context and concepts in primary school children’s systems thinking. *Journal of Biological Education*, *42*(2), 73–77.

Hmelo-Silver, C. E., & Pfeffer, M. G. (2004). Comparing expert and novice understanding of a complex system from the perspective of structures, behaviours, and functions. *Cognitive Science*, *28*, 127–138.

Hmelo, C. E., Holton, D., & Kolodner, J. L. (2000). Designing to learn about complex systems. *Journal of the Learning Sciences, 9*, 247-298.

Hoff, E. (2003a). Causes and consequences of SES-related differences in parent-to-child speech. In M. H. Bornstein, & R. H. Bradley (Eds.), *Sociocenonomic status, parenting, and child development* (pp. 147–160). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Hoff, E. (2003b). The specificity of environmental influence: Socioeconomic status affects early development via maternal speech. *Child Development*, *74*, 1368–1378.

Hoff, E., Laursen, B., & Tardif, T. (2002). Socioeconomic status and parenting. In M. H. Bornstein (Ed.), *Handbook of parenting* (2nd ed., pp. 231–252). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Hoff-Ginsberg, E. (1991). Mother-child conversations in different social classes and communicative settings. *Child Development, 62*, 782–796.

Hofstadter, D. R. (2001). Epilogue: Analogy as the core of cognition. In D. Gentner, K. J. Holyoak, & B. N. Kokinov (Eds.), *The analogical mind: Perspective from cognitive science* (pp. 499-538). Cambridge, MA: MIT Press.

Hogan, K. (1994). *EcoInquiry: A guide to ecological learning experiences for upper elementary/middle grades.* Dubuque, Kendall/Hunt.

Hohmann, M., Weikart, D. P. & Epstein, A. S. (2008). *Educating young children: Active learning practices for preschool and child care programs (3rd ed.).* Ypsilanti, MI: High/Scope Press.

Holland, J. H. (1995). Hidden order: How adaptation builds complexity. Massachusetts, USA: Basic Books.

Holloway, I., & Wheeler, S. (1997*). Qualitative Pflegeforschung. Grundlagen qualitativer Ansätze in der Pflege.* Wiesbaden: Ullstein Medical Verlag.

Holt, B.G. (1989). *Science with young children* (rev. ed.). Washington, DC: National Association for the Education of Young Children.

Hopper, M., & Stave, K. A. (2008). *Assessing the effectiveness of systems thinking interventions in the classroom.* Paper presented at the 26th International Conference of the System Dynamics Society, Athens, Greece.

Horlings, L. G. (2015). The inner dimension of sustainability: personal and cultural values. *Current Opinion in Environmental Sustainability, 14*, 163-169.

Hudson, J. A. (2006). The development of future time concepts through mother-child conversation. *Merril-Palmer Quarterly, 52*(1), 70-95.

Hudson, J. A., Shapiro, L. R., & Sosa, B. B. (1995). Planning in the real world: Preschool children’s scripts and plans for familiar events. *Child Development*, *66*, 984–998.

Hughes, C. (1998). Finding your marbles: Does preschoolers’ strategic behavior predict later understanding of mind? *Developmental Psychology, 34*, 1326–1339.

Hughes, C. (2011). Changes and challenges in 20 years of research into the development of executive functions. *Infant and Child Development, 20*, 251–271.

Hughes, C., & Ensor, R. (2005). Executive function and theory of mind in 2 year olds: A family affair? *Developmental Neuropsychology, 28*, 645–668.

Hung, W. (2008). Enhancing systems-thinking skills with modelling. *British Journal of Educational Technology*, *39*(6), 1099–1120.

Hunting, R. P. (2003). Part-whole number knowledge in preschool children. *Journal of Mathematical Behavior, 22*, 217–235.

Inhelder, B., & Piaget, J. (1958). *The growth of logical thinking from childhood to adolescence.* New York: Basic Books.

Isbell, R., & Yoshizawa, S.A. (2016). *Nurturing creativity: An essential mindset for young children's learning.* Washington, DC: National Association for the Education of Young Children.

Ison, R. L., Maiteny, P. T., & Carr, S. (1997). Systems methodologies for sustainable natural resources research and development. *Agricultural Systems, 55*, 257-272.

Ives, C. D., Abson, D. J., Wehrden, H. v., Dorninger, C., Klaniecki, K. & Fischer, J. (2018). Reconnecting with nature for sustainability. *Sustainabillity Science.* Advanced online publication. https://doi.org/10.1007/s11625-018-0542-9

Jacobsen, M. J., & Wilensky, U. (2006). Complex systems in education: Scientific and educational importance andimplications for the learning sciences. *Journal of the Learning Sciences, 15*(1), 11–34.

Johnson, D. W., & Johnson, R. T. (1996). Conflict resolution and peer mediation programs in elementary and secondary schools: A review of the research. *Review of Educational Research, 66*, 459-506.

Jones, J., Bosch, O., Drack, M., Horiuchi, Y., & Ramage, M. (2009). On the design of systems-oriented university curricula. *The Research Reports of Shibaura Institute of Technology (Social Sciences and Humanities). 43*(1), 121–130.

Jutten, J. (2004). *Natuurlinjk leren: Systeemdenken in een lerende school*. Echt: Natuurlijk leren.

Kagan, J., & Herschkowitz, N. (2005). *A young mind in a growing brain.* New York, NY: Lawrence Erlbaum Associates.

Kamerman, S. B. (2006). A global history of early childhood education and care. In *Strong foundations: Early childhood education and care.* France: UNESCO.

Kayhan, H. N., & Kılıç, D. (2011). Preschool teacher training systems in Turkey and European Union countries. *Procedia - Social and Behavioral Sciences, 15*, 3748–3752.

Katz, L. G., & Chard, S. C. (1989). *Engaging children's minds: the project approach.* Norwood, NJ: Ablex.

Katz, L. G., & Chard, S. C. (2000). *Engaging children's minds: The project approach* (2nd ed.). Stamford, CT: Ablex.

Kelley, T., & Kelley, D. (2013). *Creative confidence: Unleashing the creative potential within us all.* New York, NY: Crown Business.

Knackstredt, V., & Wellisch, M. (2005). Managing challenging behaviour: Is the environment a factor?, *Every Child, 11*(1), 30–31.

Koch, T. (1994). Establishing rigour in qualitative research: The decision trail. *Journal of Advanced Nursing, 19*, 976–986.

Kochanska, G., Coy, K. C., & Murray, K. T. (2001). The development of self-regulation in the first four years of life. *Child Development, 72*, 1091–1111.

Kohlberg, L. (1984). *The psychology of moral development: The nature and validity of moral stages.* San Francisco: Harper & Row.

Krefting, L. (1991). Rigor in qualitative research: The assessment of trustworthiness. *American Journal of Occupational Therapy, 45*(3), 214–222.

Krieg, S., Curtis, D., Hall, L., & Westenberg, L. (2015). Access, quality and equity in early childhood education and care: A South Australian study. *Australian Journal of Education, 59*(2), 119–132.

Kubow, P. K., & Fossum, P. R. (2007). *Comparative education: Exploring issues in international context.* Upper Saddle River, NJ: Pearson.

Kuhn, L. J., Willoughby, M. T., Vernon-Feagans, L., Blair, C. B., & Family Life Project Key Investigators (2016). The contribution of children’s time-specific and longitudinal expressive language skills on developmental trajectories of executive function. *Journal of Experimental Child Psychology, 148*, 20–34.

Kuhn, D., Amsel, E., & O'Loughlin, M. (1988). *The development of scientific thinking skills.* San Diego, CA: Academic Press.

Kyburz-Graber, R. (2004). Does case-study methodology lack rigour? The need for quality criteria for sound case-study research, as illustrated by a recent case in secondary and higher education. *Environmental Education Research, 10*(1), 53-65.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago, IL: University of Chicago Press.

LaVigne, A. (2009). *Systems thinking and dynamic modeling within K-12 schools: effects on student learning*. Retrieved from http://www.ppi-int.com/newsletter/SyEN-012.php#article

Lamon, S. J. (1996). The development of unitizing: Its role in children’s partitioning strategies. *Journal for Research in Mathematics Education, 27*, 170–193.

Leach, J., Driver, R., Scott, P., & Wood-Robinson, C. (1996). Children's ideas about ecology 3: Ideas found in children aged 5-16 about the interdependency of organisms. *International Journal of Science Education, 18,* 19-34.

Leach, J., Konicek, R., & Shapiro, B. (1992, April). *The ideas used by British and North American school children to interpret the phenomenon of decay: A cross-cultural study*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, California.

LeCompte, M. D., & Schensul, J. J. (1999). *Essential ethnographic methods: A mixed methods approach.* Ethnographer’s toolkit (Vol. 2). Walnut Creek, Ca: AltaMira Press.

Lee, P. (2006) Understanding and critiquing qualitative research papers. *Nursing Times, 102*(29), 30–32.

Lehrer, J. (2012). *Imagine: How creativity works.* Boston, MA: Houghton Mifflin Harcourt.

Lehrer, R., & Schauble, L. (1998). Reasoning about structure and function: Children's conceptions of gears. *Journal of Research in Science Teaching, 35*(1), 3-25.

Leiserowitz, A. A., Kates, R. W., & Parris, T. M. (2004). *Sustainability values, attitudes, and behaviors: A review of multi-national and global trends.* (CID Working Paper No. 113). Cambridge, MA: Science, Environment and Development Group, Center for International Development, Harvard University.

Lemmon, K., & Moore, C. (2001). Binding the self in time. In C. Moore & K. Lemmon (Eds.). *The self in time: Developmental perspectives* (pp. 163-179). Mahwah, NJ: Lawrence Erlbaum Associates.

Linberg, T., Baeumer, T., & Rossbach, H.-G. (2013). Data on early child education and care learning environments in Germany. *International Journal of Child Care and Education Policy, 7*(1), 24–42.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

Lipson, J. G. (1991). The use of self in ethnographic research. In J. M. Morse (Ed.), *Qualitative nursing research: A contemporary dialogue* (pp. 73–89). London, England: Sage Publications.

Lipson, J. G. (1991). The use of self in ethnographic research. In J. M. Morse (Ed.), *Qualitative nursing research: A contemporary dialogue* (pp. 73–89). London, England: Sage Publications.

Loeher, S., & Roebers, C. M. (2013). Executive functions and their differential contribution to sustained attention in 5- to 8-year-old children. *Journal of Educational and Developmental Psychology, 3*, 51–63.

Lohse, K., Kalitschke, T., Ruthmann, K., & Rakoczy, H. (2015). The Development of reasoning about the temporal and causal relations between past, present and future events. *Journal of Experimental Child Psychology, 138*, 54-70.

Lumsden, L. S. (1994). *Student motivation to learn*. Eugene, OR: ERIC Clearinghouse on Educational Management. (ERIC Document Reproduction Service No. ED370200).

Lyneis, D. (1995). *System thinking in 25 words or less*. Retrieved from www.clexchange.org/ftp/documents/whyk12sd/Y_1995-08STIn25WordsOrLess.pdf

Lyneis, D. A., & Fox-Melanson, D. (2001). *The challenge of infusing system dynamics into a K-8 curriculum*. Paper presented at the 19th International System Dynamics Society Conference, Atlanta, Georgia.

Maani, K. E., & Maharaj, V. (2004). Links between systems thinking and complex decision making. *System Dynamics Review, 20,* 21–48.

Macnaghten, P., Grove-White, R., Jacobs, M., & Wynne, B., (1995). *Public perceptions and sustainability: Indicators, institutions, participation.* Preston: Lancashire County Council.

Mandinach, E. B., & Cline H. F. (1989). Applications of simulation and modeling in precollege instruction. *Machine-Mediated Learning, 3,* 189-205.

Mantzicopoulos, P. Y. (1997). The relationship of family variables to Head Start children's preacademic competence. *Early Child Development and Care, 8,* 357–375.

Mason, M. (2007). Multiculturalism, shared values, and an ethical response to globalization. In P. D. Hershock, M. Mason, & J. N. Hawkins (Eds.). *Changing Education Leadership, Innovation and Development in a Globalizing Asia Pacific* (pp. 93-113). Springer Netherlands.

Massey, S. L. (2004). Teacher–Child Conversation in the Preschool Classroom. *Early Childhood Education Journal, (31)*4, 227-231.

Martin, N., & Baker, A. (2000). *Linking work and learning tool hit.* Portland, OR: Worksystems, Inc., & Portland, OR: Northwest Regional Educational Laboratory.

Martin-Rhee, M. M., & Bialystok, E. (2008). The development of two types of inhibitory control in monolingual and bilingual children. *Bilingualism: Language and Cognition, 11,* 81–93.

McColgan K. L., & McCormack T. (2008). Searching and planning: Young children's reasoning about past and future event sequences. *Child Development, 79,* 1477–1497.

McCormack T., & Hoerl, C. (2007). Young children's reasoning about the order of past events. *Journal of Experimental Child Psychology, 98,* 168–183.

McGuigan, F., & Salmon, K. (2004). The time to talk: The influence of the timing of adult-child talk on children's event memory. *Child Development, 75,* 669–686.

Meadows, D. H. (1982, Summer). Whole earth models and systems, *CoEvolution Quarterly,* 98-108.

Meadows, D. H. (1999). *Leverage points: places to intervene in a system*. Hartland: The Sustainability Institute.

Meadows, D. H., & Wright, D. (2008). *Thinking in systems: A primer*. White River Junction, Vt.: Chelsea Green Pub.

Metz, K. E. (1991). Development of explanation: Incremental and fundamental change in children's physics knowledge. *Journal of Research in Science Teaching, 28*(9), 785-797.

Ministry of National Education-MoNE (2013). *Okul Öncesi Eğitim Programı.* Ankara: MEB.

Merriam, S. (1998). *Case study research in education: A qualitative approach.* San Francisco, CA: Jossey-Bass.

Meyfroidt, P. (2013). Environmental cognitions, land change, and social–ecological feedbacks: an overview. *Journal of Land Use Science, 8*(3), 341–367.

Michalos, A. C., Creech, H., Swayze, N., Kahlke, P. M., Buckler, C., & Rempel, K. (2012). Measuring knowledge, attitudes and behaviors concerning sustainable development among tenth grade students in Manitoba. *Social Indicators Research, 106*, 213-238.

Mienert, M., & Vorholz, H. (2013). *Den Alltag öffnen - Perspektiven erweitern: Offene Arbeit in der Kita nach den Bildungsplänen gestaltet.* Braunschweig: Westermann Lernspielverlage.

Miles, M. B., & Huberman, M. A. (1994). *Qualitative data analysis: A sourcebook of new methods* (2nd ed.). Newbury Park, CA: Sage Publications.

Mintzes, J. J., Trowbridge, J. E., Arnaudin, M. W., & Wandersee, J. H. (1991). Children's biology: Studies on conceptual development in the life sciences. In S. M. Glynn, R. H. Yeany, & B. K. Britton (Eds.), *The psychology of learning science* (pp. 179-202). Hillsdale NJ: Erlbaum.

Mitchell, J. C. (1983). Case and situation analysis. *Sociological Review, 31*(2), 187-211.

Moore, M-L., & Westley, F. (2011). Surmountable chasms: Networks and social innovation for resilient systems. *Ecology and Society, 16*(1), 5.

Morales, J., Calvo, A., & Bialystok, E. (2013). Working memory development in monolingual and bilingual children. *Journal of Experimental Child Psychology, 114,* 187–202.

Moursund, D., Bielefeldt, T., & Underwood, S. (1997). *Foundations for The Road Ahead: Project-based learning and information technologies.* Washington, DC: National Foundation for the Improvement of Education.

M'Pherson, P. K. (1974). A perspective on systems science and systems philosophy. *Futures, 6*(3), 219–239.

National Association for the Education of Young Children (NAEYC) (2009). *Standards for early childhood professional preparation programs.* Retrieved from http://www.naeyc.org/files/naeyc/file/positions/ProfPrepStandards09.pdf

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics.* Reston, VA: National Council of Teachers of Mathematics.

NCTAF (National Commission on Teaching and America's Future) (1996). What matters most: Teaching for America's future. New York: NCTAF.

National Quality Framework (2018). Quality Area 3-Physical Environment. Australian Children's Education and Case Quality Authority. Retrieved from https://www.acecqa.gov.au/nqf/national-quality-standard/quality-area-3-physical-environment

National Research Council (2000). How people learn: Brain, mind, experience and school. In J. D. Bransford, A. L. Brown, R. R. Cocking, & S. Donovan (Eds.). *Early Childhood Development and Learning: New Knowledge for Policy*. Washington, DC, USA: National Academy Press.

Neuman, W. L. (1997). *Social research methods, qualitative and quantitative approaches* (3rd ed.). Boston: Allyn and Bacon.

Nguyen, N. C., Graham, D., Ross, H., Maani, K., & Bosch, O. J. H. (2012). Educating systems thinking for sustainability: Experience with a developing country. *Systems Research and Behavioral Science, 29*(1), 14-29.

Nixon, R. (2011). *Slow violence and the environmentalism of the poor.* Cambridge, MA, USA: Harvard University Press.

Novick, L. R. (1992). The role of expertise in solving arithmetic and algebra word problems by analogy. In J. I. D. Campbell (Ed.), *The nature and origins of mathematical skills* (pp.155-188). Amsterdam: Elsevier.

Odum, H. T., & Odum, E. C. (2001). *A Prosperous way down: principles and policies*. USA: University Press of Colorado.

Oh, S., & Lewis, C. (2008). Korean preschoolers’ advanced inhibitory control and its relation to other executive skills and metal state understanding. *Child Development, 79,* 80–99.

Organisation for Economic Co-operation and Development (OECD) (2013). *Education Policy Outlook: Turkey*. Retrieved from http://www.oecd.org/edu/EDUCATION%20POLICY%20OUTLOOK%20TURKEY_EN.pdf

Organisation for Economic Co-operation and Development (OECD) (2014a). *Education at a glance: OECD Indicators. Country report, Germany.* Retrieved from https://www.oecd.org/edu/Germany-EAG2014-Country-Note.pdf

Organisation for Economic Co-operation and Development (OECD) (2014b). *Education at a glance: OECD Indicators. Country report, Turkey*. Retrieved from https://www.oecd.org/edu/Turkey-EAG2014-Country-Note.pdf

Orr, D. W. (2004). *Earth in mind: On education, environment and the human prospect.* Washington: Island Press.

Ossimitz, G. (2000). *Teaching system dynamics and systems thinking in Austria and Germany*. Paper presented at the 18th International Conference of the System Dynamics Society, Bergen, Norway.

Patton, E., & Appelbaum, S. H. (2003). The case for case studies in management research. *Management Research News*, *26*(5), 60-71.

Patton, M. (1980). *Qualitative evaluation and research methods.* Newbury Park, CA: Sage Publications.

Patton, M. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage Publications.

Patton, M. Q. (2002). *Qualitative research and evaluation methods.* Thousand Oaks, CA: Sage Publications.

Payne, A. C., Whitehurst, G. J., & Angell, A. L. (1994). The role of home literacy environment in the development of language ability in preschool children from low-income families. *Early Childhood Research Quarterly, 9*, 427–440.

Pegram, A. (2000). What is case study research? *Nurse Researcher, 7*(2), 5-16.

Penner, D. E. (2000). Explaining systems: investigating middle school students' understanding of emergent phenomena. *Journal of Research in Science Teaching, 37*(8), 784–806.

Perkins D. N., & Grotzer, T. A. (2005) Dimensions of causal understanding: The role of complex causal models in students' understanding of science. *Studies in Science Education, 41*, 117-165.

Perner, J., & Ruffman, T. (1995). Episodic memory and autonoetic consciousness: Developmental evidence and a theory of childhood amnesia. *Journal of Experimental Child Psychology, 59*, 516–548.

Piaget, J. (1952). *The origins of intelligence in children.* New York: Norton.

Pink, D. H. (2005). *A whole new mind why right-brainers will rule the future.* New York: Riverhead Books.

Placek, J. H. (1984). A multi-case study of teacher planning in physical education. *Journal of Teaching in Physical Education, 4*, 39-49.

Plate, R. (2006). *Assessing the effectiveness of systems-oriented instruction for preparing students to understand complexity* (Unpublished doctoral dissertation). University of Florida.

Plate, R. (2010). Assessing individuals' understanding of nonlinear causal structures in complex systems. *System Dynamics Review, 26*(1), 19–33.

Plate, R., & Monroe, M. (2014, Winter). A structure for assessing systems thinking. *The Creative Learning Exchange, 23*(1).

Platt, J. (1992). 'Case study' in American methodological thought. *Current Sociology, 40*(1),17-48.

Poarch, G. J., & van Hell, J. G. (2012). Executive functions and inhibitory control in multilingual children: Evidence from second language learners, bilinguals, and trilinguals. *Journal of Experimental Child Psychology, 113,* 535–551.

Poljac, E., de-Wit, L., & Wagemans, J. (2012). Perceptual wholes can reduce the conscious accessibility of their parts. *Cognition, 123*(2), 308–312.

Porter, T., & Córdoba, J. (2009). Three views of systems theories and their implications for sustainability education. *Journal of Management Education, 33*(3), 323-347.

Poulin-Dubois, D., Blaye, A., Coutya, J., & Bialystok, E. (2011). The effects of bilingualism on toddlers' executive functioning. *Journal of Experimental Child Psychology, 108*, 567–579.

Pourdehnad, J. (1992). *Interactive planning: Its impact on the process of an organization's development.* (Unpublished doctoral thesis). University of Pennsylvania, Philadelphia.

Project Zero (2003). *Making teaching visible: Documenting individual and group learning as professional development.* Cambridge, MA: Harvard University.

Ragin, C. C., & Becker, H. S. (Eds.) (1992). *What is a case? Exploring the foundations of social inquiry.* Cambridge: Cambridge University Press.

Railsback, J. (2002). *Project-based instruction: Creating excitement for learning.* Portland, OR: Northwest Regional Educational Laboratory. Reading, MA: Perseus Books.

Redfield, D., & Rousseau, E. (1981). A meta-analysis of experimental research on teacher questioning behavior. *Review of Educational Research, 51*(2), 237-245.

Richland, L. E., & Burchinal, M. R. (2003). Early executive function predicts reasoning development. *Psychological Science, 24*(1), 87– 92.

Richland, L. E., Morrison, R. G., & Holyoak, K. J. (2006). Children's development of analogical reasoning: Insights from scene analogy problems. *Journal of Experimental Child Psychology, 94*, 249–273.

Richmond, B. (1991). *Systems thinking: Four key questions.* Watkinsville, GA: High Performance Systems.

Richmond, B. (1993). Systems thinking: Critical thinking skills for the 1990s and beyond. *Systems Dynamic Review, 9*(2), 113-133.

Richmond, B. (1994). *Systems dynamics/systems thinking: Let's just get on with it*. Paper presented at the International Systems Dynamics Conference, Sterling, Scotland.

Rickinson, M., Dillon, J., Teamey, K., Morris, K., Choi, M. Y., Sandres, D., & Benefield, P. (2004). *A review on outdoor learning.* UK: Field Studies Council.

Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures*, *44*(2), 127–135.

Rihani, S. (2002). *Complex systems theory and development practice.* New York: Zed Books.

Rinaldi, C. (1998). Projected curriculum construction through documentation—Progettazione. In C. Edwards, L. Gandini, & G. Forman (Eds.), *The hundred languages of children: The Reggio Emilia approach—Advanced reflections* (2nd ed.). Greenwich, CT: Ablex.

Rudolph, K D., & Heller, T. (1997). Interpersonal problem solving, externalizing behavior, and social competence in preschoolers: A knowledge-performance discrepancy? *Journal of Applied Developmental Psychology, 18,* 107-117.

Runco, M. A. (2014). *Creativity: Theories and Themes: Research, development, and practice* (2nd ed.). London, UK: Elsevier.

Russell, J., Alexis, D., & Clayton, N. (2010). Episodic future thinking in 3- to 5-year-old children: The ability to think of what will be needed from a different point of view. *Cognition*, *114,* 56–71.

Sammons, P., Sylva, K., Melhuish, E., Siraj-Blatchford, I., Taggart, B., Hunt, S., & Jelicic, H. (2008). *Effective pre-school and primary education 3-11 project (EPPE): Influences on children's cognitive and social development in Year 6*. London: Institute of Education, University of London.

Samuelsson, I. P., & Kaga, Y. (Eds.) (2008). *The contribution of early childhood education to a sustainable society.* Paris: UNESCO.

Sandelowski, M. (1996). One is the liveliest number: The case orientation of qualitative research. *Research in Nursing and Health, 19*(6), 525–529.

Sauter, M. B., & Frohlich T. C. (2013). *The most educated countries in the world.* Retrieved from http://247wallst.com/special-report/2013/10/15/the-most-educated-countries-in-the-world-2/

Schatzman, L., & Strauss, A. L. (1973). *Field research: Strategies for a natural sociology*. Upper Saddle River, NJ: Prentice Hall.

Schumacher, E. F. (1997). *'This I believe' and other essays.* Dartington: Green Books (essay first published in 1974).

Seidel, S. (2001). Understanding documentation starts at home. In C. Giudici, C. Rinaldi, & M. Kreshevsky (Eds.), *Making learning visible: Children as individual and group learners* (pp. 304-311). Reggio Emilia, Italy: Reggio Children.

Selman, R. L. (1980). *The growth of interpersonal understanding: Developmental and clinical analyses.* New York: Academic Press.

Selman, R. L. (1981). The development of interpersonal competence: The role of understanding in conduct. *Developmental Review, 1*, 401-422.

Senge, P. M., Aleiner, A., Roberts, C., Ross, R., & Smith, B. (1994). *The fifth discipline fieldbook: Strategies and tools for building a learning organization.* New York: Doubleday.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization.* New York: Doubleday.

Senge, P. M. (1991). *The fifth discipline. The summary in brief*. Soundview Executive Book Summaries.

Senge, P. M., Cambron-McCabe, N., Lucas, T., & Smith, B. (2000). *Schools that learn (updated & revised): A fifth discipline fieldbook for educators, parents, and everyone who cares about education.* New York: Doubleday.

Senge, P. M. (2001). Comments on illuminating the blind spot: Leadership in the context of emerging worlds. Retrieved from http://www.dialogonleadership.org/Senge Comment.html

Senn, T. E., Espy, K. A., & Kaufmann, P. M. (2004). Using path analysis to understand executive function organization in preschool children. *Developmental Neuropsychology, 26*, 445-464.

Sheehy, N. P., Wylie, J. W., McGuinness, C., & Orchard, G. (2000). How children solve environmental problems: Using computer simulations to investigate systems thinking. *Environmental Education Research, 6*, 109–126.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22,* 63–75.

Silver, E. A. (1981). Recall of mathematical problem formulation: Solving related problems. *Journal for Research in Mathematics Education, 12*(1), 54-64.

Simon. H. A. (1955). A behavioral model of rational choice. *Quarterly Journal of Economics, 69*(1), pp. 99-118,

Skaza, H., & Stave, K. (2010). *Assessing the effect of systems simulations on systems understanding in undergraduate environmental science courses*. Paper presented at the 28th International Conference of the System Dynamics Society, Seoul, Korea.

Snow, C. E., Burns, M. S., & Griffin, P. (Eds) (1998). *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.

Son, S.-H., Lee, K., & Sung, M. (2013). Links between preschoolers' behavioral regulation and school readiness skills: The role of child gender. *Early Education and Development, 24*, 1–23.

Soydan, S. (2014). A comparative study on the environmental attitudes of 60-66-months-old children and their mothers. *Mevlana International Journal of Education, 4*(2), 27-37.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.

Stake, R. E. (2006). *Multiple case study analysis.* New York: Guilford Press.

Stata, R. (1989). Organizational learning: The key to management innovation. *Sloan Management Review, Spring,* 63–74.

Stave, K., & Hopper, M. (2007). *What constitutes systems thinking? A review of practitioner views.* Paper presented at the 25th International Conference of the System Dynamics Society, Boston, MA.

Stavy, R., & Tirosh, D. (1993). When analogy is perceived as such. *Journal of Research in Science Teaching 30*(10), 1229-1239.

Sterling, S. (1996). Education in change. In J. Huckle, & S. Sterling (Eds.), *Education for sustainability* (pp. 18-39). London: Earthscan Publications Ltd.

Sterling, S. (2001). *Sustainable Education.* Devon, England: Green Books.

Sterling, S. (2003). *Whole systems thinking as a basis for paradigm change in education: Explorations in the context of sustainability.* (Unpublished doctoral thesis). Centre for Research in Education and the Environment, University of Bath, UK.

Sterling, S. (2008). Sustainable education - towards a deep learning response to unsustainability. *Policy & Practice: A Development Education Review, 6*, 63-68.

Sternberg, R. J., & Rifkin, B. (1979). The development of analogical reasoning processes. *Journal of Experimental Child Psychology, 27,* 195-232.

Stevahn, L., Johnson, D., Johnson, R., Oberle, K, & Wahl, L. (2000). Effects of conflict resolution training integrated into a kindergarten curriculum. *Child Development, 71*, 772-784.

Strauss, A., & Corbin, J. (2008). *Basics of qualitative research: Grounded theory procedures and techniques* (3rd ed.). Newbury Park, CA: Sage Publications.

Storksen, I., Ellingsen, I. T., Wanless, S. B., & McClelland, M. M. (2015). The influence of parental socioeconomic background and gender on self-regulation among 5-year-old children in Norway. *Early Education and Development, 26*, 663–684.

Strasser, J., & Bresson, L. M. (2017). *Big questions for young minds: Extending children's thinking*. Washington, DC: National Association for the Education of Young Children.

Stuss, D. T. (2007). New approaches to prefrontal lobe testing. In B. L. Miller, & J. L. Cummings (Eds.), *The human frontal lobes: Functions and disorders* (*2nd ed.*, pp. 292–305). New York, NY: Guilford Press.

Suddendorf, T. (2010). Linking yesterday and tomorrow: Preschoolers' ability to report temporally displaced events. *British Journal of Developmental Psychology, 28*(2), 491-498.

Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans? *Behavioural and Brain Sciences, 30*, 299-351.

Suddendorf, T., & Redshaw, J. (2013). The development of mental scenario building and episodic foresight. *Annals of the New York Academy of Sciences, 1296*(1), 135-153.

Sweeney, L. B., & Sterman, J. D. (2000). Bathtub dynamics: Initial results of a systems thinking inventory. *System Dynamics Review, 16*, 249-294.

Sweeney, L. B. (2001). *When a butterfly sneezes: A guide for helping kids explore interconnections in our world through favorite stories.* Waltham, MA: Pegasus Communications.

Sweeney, L. B., & Sterman, J. D. (2007). Thinking about systems: Student and teacher conceptions of natural and social systems. *System Dynamics Review, 23*(2), 285-312.

Taylor, S. J., & Bogdan, R. (1998). *Introduction to qualitative research methods: A guidebook and resource* (3rd ed.). New York: Wiley.

Taylor, C., Ferguson, L., Tudor, M., & Angell, T. (2001). *Environmental education frameworks that integrate Washington State's standards.* (rev. ed.) Pacific Education Institute Technical Report Number 1.

Tellis, W. M. (1997). Application of a case study methodology. *The Qualitative Report, 3*(3), 1-19.

The Donella Meadows Project (n.d.). *Leverage points: Places to intervene in a system.* Retrieved April 17, 2018, from http://donellameadows.org/

The Waters Foundation (n.d.). *The impact of the systems thinking in schools project: 20 years of research, development and dissemination.* Retrieved April 17, 2018, from http://watersfoundation.org/wp-content/uploads/2017/07/STIS_Research.pdf

Thibaut, J.-P., French, R., & Vezneva, M. (2010). The development of analogy making in children: Cognitive load and executive functions. *Journal of Experimental Child Psychology*, *106*, 1–19.

Thomas, J.W. (1998). *Project based learning overview.* Novato, CA: Buck Institute for Education.

Thomas, J. W. (2000). A review of research on project-based learning. Report prepared for The Autodesk Foundation. Retrieved from http://www.bie.org/index.php/site/RE/pbl_research/29

Thompson, R. A., & Nelson, C. A. (2001). Developmental science and the media: Early brain development. *American Psychologist, 56*(1), 5–15.

Thompson, T. D. (2004). Can the caged bird sing? Reflections on the application of qualitative research methods to case study design in homeopathic medicine. *British Medical Council Medical Research Methodology, 4*(4), 1–17.

Thornton, B., Peltier, G., & Perreault, G. (2004). Systems thinking: A skill to improve student achievement. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *77*(5), 222–227.

Thwink.org (n.d.). *Finding and resolving the root causes of sustainability problem.* Retrieved April 17, 2018, from http://www.thwink.org

Tilbury, D., Coleman, V., & Garlick, D. (2005). *A National Review of Environmental Education and its Contribution to Sustainability in Australia: School Education.* Canberra: Department of the Environment and Heritage and Australian Research Institute in Education for Sustainability (ARIES).

Tokuhama-Espinosa, T. (2010). *The new science of teaching and learning: Using the best of mind, brain, and education science in the classroom*. New York, NY: Teachers College Press.

Tomlinson, C. A., Gould, H., Schroth, S., & Jarvis, J. (2006). *Multiple case studies of teachers and classrooms successful in supporting academic success of high potential low economic students of color* (Research Monograph No. 06220). Storrs: The National Research Center on the Gifted and Talented, University of Connecticut.

Transfer 21 Programme (2007). *Developing quality at "ESD Schools" quality areas, principles and criteria.* Berlin: Freie Universität Berlin.

Ulrich, W. (1993). Some difficulties of ecological thinking, considered from a critical systems perspective: A plea for critical holism. *Systems Practice, 6*(6), 583-611.

UN (2015). *Transforming our world: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015*. Retrieved from https://sustainabledevelopment.un.org/post2015/transformingourworld

UNECE (n.d.). *National implementation reports.* Retrieved September 26, 2017, from http://www.unece.org/env/esd/implementation.html

UNECE (2016). *Learning from each other: achievements, challenges and ways forward. Third evaluation report of the UNECE Strategy for Education for Sustainable*

Development. Geneva. Retrieved from http://www.unece.org/fileadmin/DAM/env/esd/11thMeetSC/Documents/1521609E.pdf

UNESCO (2002). *Education for sustainability - From Rio to Johannesburg: Lessons learnt from a decade of commitment.* Retrieved from http://unesdoc.unesco.org/images/0012/001271/127100e.pdf

UNESCO (2007). *The UN decade of education for sustainable development (DESD 2005-2014). The first two years*. Retrieved from http://unesdoc.unesco.org/images/0015/001540/154093e.pdf

UNESCO (2009). *Bonn Decleration.* Retrieved from http://www.esd-world-conference-2009.org/fileadmin/download/ESD2009_BonnDeclaration.pdf

UNESCO (2017a). *Education for sustainable development: Partners in action*. Paris. Retrieved from http://unesdoc.unesco.org/images/0025/002597/259719e.pdf

UNESCO (2017b). *Education for sustainable development goals: Learning objectives*. Paris. Retrieved from http://unesdoc.unesco.org/images/0024/002474/247444e.pdf

UNICEF (2017). *Early moments matter for every child.* New York. Retrieved from https://www.unicef.org/publications/files/UNICEF_Early_Moments_Matter_for_Every_Child.pdf

Valerdi, R., & Rouse, W. B. (2010). When systems thinking is not a natural act. In *Proceedings of the 5th IEEE Systems Conference* (pp. 184-189). San Diego, CA.

Vineland K-12 (n.d.). *21st century Interdisciplinary themes and skills assessment rubric kindergarten – grade 2.* Retrieved April, 17 2016, from http://vineland.k12.ca.us/wp-content/uploads/sites/13/2014/07/Systems-Thinking-Grades-K-2.pdf

Vosniadou, S. (1995). Analogical reasoning in cognitive development. *Metaphor and symbolic activity, 10(4),* 297-308.

Waddock, S. (2006). *Leading corporate citizens: Vision, values, value-added* (2nd ed.). New York: McGraw Hill.

Wade, J. (2011). *Systems engineering: At the crossroads of complexity*. Paper presented at the Kongsberg Systems Engineering Event (KSEE), Krona, Kongsberg, Norway.

Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on socioeconomic status and early language production. *Child Development, 65*, 606–621.

Wals, A. E. J. (2006). The end of ESD…the beginning of transformative learning. Emphasizing the E in ESD. In M. Cantell (Ed.), *Proceedings of the Seminar on Education for Sustainable Development* (pp. 42–59). Retrieved April 17, 2018, from http://library.wur.nl/WebQuery/wurpubs/353568

Wals, A., & Corcoran, P. B. (Eds.). (2012). *Learning for sustainability in times of accelerating change.* Wageningen, The Netherlands: Wageningen Academic Publishers.

Wals, A. E. J. (2015). *Beyond unreasonable doubt - Education and learning for socio-ecological sustainability in the anthropocene*. *Inaugural address held upon accepting the personal Chair of Transformative Learning for Socio-Ecological Sustainability at Wageningen University*. Retrieved from http://edepot.wur.nl/365312

Wanless, S. B., McClelland, M. M., Lan, X., Son, S.-H., Cameron, C. E., Morrison, F. J., Chen, F.-M., Chen, J.-L., Li, S., Lee, K., & Sung, M. (2013). Gender differences in behavioral regulation in four societies: The United States, Taiwan, South Korea, and China. *Early Childhood Research Quarterly, 28*, 621–633.

Waters Foundation Rubric (n.d.). *CFSD 21st century learning rubric for systems thinking.* Retrieved January, 17 2016, from http://www.watersfoundation.org/wp-content/uploads/2013/02/Systems-Rubrics.pdf

Waters Foundation (2015). *Habits of a systems thinker*. Pittsburgh, PA: Waters Foundation. Retrieved from http://watersfoundation.org/systems-thinking/habits-of-a-systems-thinker/

Waters Foundation (2016). *Early childhood – systems thinking and children's literature*. Retrieved from http://watersfoundation.org/resources/early-childhood-literature/

Webb, P., & Boltt, G. (1990). Food chain to food web: A natural progression? *Journal of Biological Education, 24*(3), 187-190.

Weigel, D. J., Martin, S. S., & Bennett, K. K. (2006). Contributions of the home literacy environment to preschool-aged children's emerging literacy and language skills. *Early Child Development and Care, 176*, 357-378.

West, J., & Oldfather, P. (1995). Pooled case comparison: An innovation for cross-case study. *Qualitative Inquiry*, *1*(4), 452–464.

Wiek, A., & Lang, D. J. (2014). Transformational sustainability research methodology. In H. Heinrichs, P. Martens, G. Michelsen, & A. Wiek (Eds.) *Sustainability Science – An Introduction* (pp. 31-41). Berlin, New York: Springer.

Wiek, A., Ness, B., Brand, F.S., Schweizer-Ries, P., & Farioli, F. (2012). From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects, *Sustainability Science, 7*(1), 5-24.

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science, 6*(2), 203-218.

Wiek, A., Xiong, A., Brundiers, K., & van der Leeuw, S. (2014). Integrating problem- and project-based learning into sustainability programs: A case study on the School of Sustainability at Arizona State University, *International Journal of Sustainability in Higher Education*, *15*(4), 431-449.

Wilber, K. (1996). *A brief history of everything.* Dublin: Gill and Macmillan.

Wilson, S. (1977). The use of ethnographic techniques in educational research. *Review of Educational Research*, *47*(2), 245-265.

Witjes, S., Muñoz Specht, P., & Montoya-Rodríguez, C. (2006). The measurement of the development of systems and general thinking in agricultural areas of Colombia: Preliminary results. In *Proceedings of the 50th Annual Meeting of the International Society for the Systems Sciences*.

Wood-Robinson, C. (1995). Children's biological ideas: Knowledge about ecology, inheritance, and evolution. In S. M. Glynn, & R. Duit (Eds.), *Learning science in the schools: Research informing practice* (pp. 111-131). Mahwah NJ: Erlbaum.

World Ocean Review (WOR). (2010). *Living with the oceans.* Retrieved from http://worldoceanreview.com/

Worldwide Fund for Nature (WWF) (2005). *Linking thinking: New perspectives on thinking and learning for sustainability.* Aberfeldy: WWF Scotland.

Wu, H-K. (2010). Modelling a complex system: Using novice-expert analysis for developing an effective technology-enhanced learning environment. *International Journal of Science Education, 32*(2), 195–219.

Wulun, J. (2007). Understanding complexity, challenging traditional ways of thinking. *Systems Research and Behavioral Science, 24*, 393–402.

Yates, J., & Davidson, A. (n.d.). *Seeing below the surface: Systems thinking.* Retrieved from http://www.watersfoundation.org/webed/library/articles/STarticle-07.pdf

Yin, R. K. (1994). *Case study research: Design and methods.* Thousand Oaks, CA: Sage Publications.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage Publications.

Yoon, S. A. (2008). An evolutionary approach to harnessing complex systems thinking in the science and technology classroom. *International Journal of Science Education, 30*(1), 1–32.

Young-Loveridge, J. M. (2002). Early childhood numeracy: Building an understanding of part-whole relationships. *Australian Journal of Early Childhood, 27*(4), 3–42.

Young-Loveridge, J., Peters, S., & Carr, M. (1998). Enhancing the mathematics of four year olds: An overview of the EMI-4s study. *Journal of Australian Research in Early Childhood Education, 1*, 82–93.

Yuen, L. H. (2010). A valuable experience for children: The dim sum and Chinese restaurant project. *Early Childhood Research & Practice, 12*(1), 23–31.

Zelazo, P. D., Blair, C. B., & Willoughby, M. T. (2016). *Executive function: Implications for education. NCER 2017–2000*. Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13-39). San Diego: Academic Press.

Zucker, D. M. (2001). Using case study methodology in nursing research. *The Qualitative Report*, *6*(2), 1-9.

APPENDICES

A: THE CHILD STORY AND THE CHILD INTERVIEW PROTOCOL

Down to the secret water hole the animals all come.
As seasons bring forth drought and flood, they gather as one.
United in their common need, their numbers swell to ten.

One rhino
drinking at the water hole.
“Mmm, delicious!”
Interview Question 1: Where did the water come from?

Two tigers
lapping at the water hole.
“Grrrrrrr”

Three toucans
squawking around the water hole.
“It is party time, fellas! Drink it up”

But something was happening…
Interview Question 2: Something has begun to change, can you think about what has changed? What do you think happened?

Four snow leopards
gazing at the water hole.
(We must be careful, brothers)

Five moose
wallowing in the water hole.
(Hey, get your hoof out of my ear!)

The water hole was getting smaller and smaller…

Six catfish
floundering in the water hole.
(Blub, blub, blub)

and smaller…

Seven pandas
Sipping at the water hole.
(I've already drank my friend, you can drink as well if you want)

Eight ladybugs
meeting by the water hole and chatting.

Nine tortoises
lumbering around at the water hole, which is almost dried up.

Ten kangaroos
looking at the water hole.
There was nothing to say.
The water was all gone.
Interview Question 3: Where did the water go?

And all the animals went away.
Interview Question 4: Where did the animals go?

Then a shadow fell across the sun.
Clouds began to gather.
A single drop of rain fell.

It rained and rained and rained and rained…
All the animals came back!

Interview questions posed after reading the story:

5- What was this story about?

6- What did the animals in the story do?

7- Why do you think they did … (drink, go away etc.)?

8- Why has the water decreased?

9- What happened when the number of the animals increased?

10- What happened when the amount of water decreased?

11- What happened when there was no water anymore? Why?

12- Where did the animals go?

13- What caused the animals come back to the forest?

14- Do some kinds of things keep happening over and over in the story?

15- Who/what else need/use water? How?

16- What would happen if there were also humans in the story?

17- How would you solve this problem if you were one of the animals in this story?

18- Please continue the story. What do you think will happen next? And then… and then.. How will be the end of story?

19- Give a title to the book.

B: THE SYSTEMS THINKING DEVELOPMENTAL RUBRIC FOR K-LEVEL

Some Explanations

This rubric was developed as a systems thinking assessment tool as a part of a doctorate research, which is a comparative study focusing on the systems thinking skills of 4-6-year-old children living in Turkey and Germany. In total, the data from the interviews of 52 children from Turkey and Germany were analyzed using this rubric.

The child interviews were based on reading a story (The Water Hole by Graeme Base), and the children were asked questions related to the story. The responses of children were analyzed by using this rubric which includes various examples which were selected from the interviews and the children's responses.

If a child provided two explanations in which a lower level response was elaborated by a higher-level one, then the higher-level explanation was scored.

For no response or the child answering, "I don't know", no score was given.

The total scores should range from 0 to 24.

Dynamic Thinking

Questions: Something has begun to change, can you think of what has changed? Do some kinds of things keep happening over and over in the story?

Main assessment aim: To detect the children’s dynamic thinking ability considering whether they can understand changes in the components and processes that construct obvious and hidden patterns in the system.			
Level 1 (Score=0)	Level 2 (Score=1)	Level 3 (Score=2)	Level 4 (Score=3)
<u>*No Change*</u> The child does not notice any change in system components. Example: “Nothing happens to the water”.	<u>*Obvious Sudden Change*</u> The child notices changes at the back-and-forth or existence-presence level. However, s/he does not describe the dynamic behavior using a gradual time-view. Example: “Water has gone; it came back”.	<u>*Obvious Gradual Change*</u> The child is able to trace the dynamic behavior noticing that there is a gradual change when a gradual time-perspective was given. Example: “There is less and less water each time”.	<u>*Hidden Pattern*</u> The child is able to detect a circular dynamic behavior pattern through a much longer time-view and incorporates both obvious and hidden components and processes. Example: “Because the sun is drying the water, a little water goes up into the clouds. Then, it comes down to earth again”.

One-Way Causality

Why do you think animals did….? What happened when there was no water anymore? Why? What caused the animals come back to the forest?

Main assessment aim: To assess the connections that children see in the story considering whether they detect the domino causality and multiple causality, as well as direct and indirect connections.			
Level 1 (Score=0)	Level 2 (Score=1)	Level 3 (Score=2)	Level 4 (Score=3)
No Causality The child does not build any linear cause-and-effect relationship. Example: "Animals drink from the water because they want to".	*One-Way Simple Causality* The child builds a one-way relationship between one cause and one effect. Example: "There was less and less water available, because animals drank it".	*Two-Step Domino Causality* The child describes two-step linear connections that result in direct and indirect effects. Example: "If there is no water, we can't wash our hands. Then, there will be bacteria all over our body". **OR** *Multiple One-Way Simple Causality* The child can detect multiple causes and/or multiple effects, such as A and B being causes of C and/or D causing E and F. Since the story openly provides one cause-one effect relationships to children, this level requires abstract thinking. Example: "The amount of water is decreasing because there is no rain, and animals have been drinking it".	*One-Way Three or More-Step Domino Causality* The child describes an extended linear pattern that includes a multi-step linear connection of three or more steps with indirect effects. Example: "If there is no water, we can't wash our hands. Then, there will be bacteria all over our body and we will get sick".

Feedback Thinking

Questions: What happened when the number of the animals increased? What happened when the amount of water decreased? What would you have done if you were one of the animals in the story?

Main assessment aim: To measure the children's ability to detect the behaviors in the system that can "feedback" to form positive and negative processes.			
Level 1 (Score=0)	Level 2 (Score=1)	Level 3 (Score=2)	Level 4 (Score=3)
<u>Open loop</u> The child notices one-way linear connections. The child is not aware of the reciprocal connection between components. Example: "The animals left because the water was gone"	*<u>Closed loop</u>* The child closes the loop by describing the mutual relationship between components (the child explains how one component affects a second component, and how it returns and affects the first component (as in the Waters Foundation document). S/he does not, however, describe the behavior of this feedback structure over time. Example: "When there is no water, then there are no animals. When there is water, the animals come back to the forest (existence of animals depends on the existence of water). Water depletion was caused by the animals (existence of animals affects the water)".	*<u>Behavior of closed loop over time</u>* The child closes the loop, continues to trace causal relationships around the loop and describes the behavior of the feedback loop, noticing that the oscillating behavior continues to bounce off each relationship over time (a degree of impact is added) Example: "The more animals come to the water hole, the more they drink the water, and the less water is available, the less the animals remain in the forest".	*<u>Multiple closed loops</u>* The child describes behavior of a balancing and a reinforcing loop. Example: "The more animals come to the water hole, the more they drink from the water. The less water is available, the less animals stay in the forest (balancing feedback). I would catch some of the animals so that their number won't increase (reinforcing feedback because the child is aware of the fact that population will rise due to the new members)".

Hidden Dimension

Questions: Where did the water come from? Why has the water decreased? Where did the water go? Where did the animals go? Who/what else need/use water?

Main assessment aim: To measure the children's ability to detect obvious and hidden components and processes in the system.			
Level 1 (Score=0)	Level 2 (Score=1)	Level 3 (Score=2)	Level 4 (Score=3)
Obvious components and processes The child only describes obvious components and processes. The child is not aware of the hidden components and/or processes. Example: Animal, water, rain.	*Lower Level Hidden Components* The child identifies up to two hidden components Example: Flowers, human beings, sun	*Higher Level Hidden Components* The child identifies more than two hidden components Example: Beaver (the child created a theory: there is a beaver under the water hole and it withdraws water from it), something under the water, flowers, trees	*Hidden Processes* The child describes hidden processes. Example: "The sun dries up the water" or "water comes from or goes underground".

Big Picture Thinking
Questions: What was this story about? Give a title to the book.

Main assessment aim: To measure children's ability to demonstrate a multiple perspective approach and comprehend a given issue through more holistic perspective.			
Level 1 (Score=0)	Level 2 (Score=1)	Level 3 (Score=2)	Level 4 (Score=3)
No response to both of the Questions The child does not provide any response to both questions. Example: "I don't know"	*Uni-dimensional Perspective* The child provides responses to both of the questions that focus on one dimension in the story. Example: "The story is about the water" "Title of the book can be the Animals"	*Partial Multi-dimensional Perspective* The child provides one multi-dimensional response to one of the questions and displays relatively more holistic look to issues. Example: The child provides problem-oriented OR habitat-oriented OR combination of user-resource-oriented responses "The story is about the Drought" **OR** "Title of the book can be as follows: animals are lacking water"	*Full Multi-dimensional Perspective* The child provides two multi-dimensional responses to both of the questions and displays relatively more holistic look to issues. Example: The child provides problem-oriented OR habitat-oriented OR combination of user-resource-oriented responses "The story is about the Drought" **AND** "Title of the book can be as follows: animals are lacking water"

Understanding the System Mechanisms

Questions: What would happen if there were also humans in the story?

Main assessment aim: To detect the children's understanding of the systems mechanisms by adding a new component to the system.			
Level 1 (Score=0)	Level 2 (Score=1)	Level 3 (Score=2)	Level 4 (Score=3)
No change The child describes that there would be no change in the system at all. Example: "Everything would be the same".	*Local Anticipated Impact* The child describes only potential local and short-term impacts of the addition of the new component to the system. Example: "Humans could use the water as well". "Humans could scare the animals away". "They could look after the animals, give them water".	*Broader Anticipated Impact* The child describes wider and long-term potential impacts of adding the new component to the system. Example: "Humans would use the water, and water would disappear even more quickly".	*Unexpected Impact* The child considers the possibility of unexpected changes in the system. Example: "Humans will hunt some of the animals so that there will be enough water for the rest of animals, and none of the animals has to move to another place. This time, humans will decide on destroying the habitat of the animals. This would make the animals unhappy and they would decide to scare the humans, etc."

Problem Solving

Question: How would you solve this problem if you were one of the animals in this story?

<table>
<tr><td colspan="4">Main assessment aim: To detect the children's problem solving ability in a given problematic system behavior. In this context, rather than being a third-party helper, the children are asked to identify themselves with a component in a given situation and find a solution in the operating system.</td></tr>
<tr><td>Level 1 (Score=0)</td><td>Level 2 (Score=1)</td><td>Level 3 (Score=2)</td><td>Level 4 (Score=3)</td></tr>
<tr><td><u>Irrelevant or no response</u>

The child does not provide a valid response.

Example: "I would be a kangaroo, and I would jump into the toy box".</td><td><u>Doing nothing</u>

The child explains that it is not necessary to do anything because the water will come back anyway (gets score because s/he notices the most recognizable pattern regarding the water and bases her/his solution on this pattern).

Example: "I would do nothing; the water will come back again. So there is no need to do anything".</td><td><u>Low leverage of interventions</u>

The child provides a quick fix approach to the problem, such as increasing the amount of water or reducing or suspending water consumption. S/he is not aware that those solutions will create new problems.

Example: "I would do rain dance so that there would be more water".

"I would drink less and less water".</td><td><u>High leverage of interventions</u>

The child demonstrates a longer term diagnostic approach by focusing on possible root causes or offering more sophisticated intervention points, such as acting in time before the water has fully dried up (being aware of the delay in the system) or distributing the resource fairly.

Example: "Before the water was fully-consumed, I would gather all the animals together and we would talk about what to do and who could help us".</td></tr>
</table>

Time Dimension-Future Prediction

Please continue the story. What do you think will happen next? And then… and then.. How will be the end of story?

Main assessment aim: To detect children's ability to predict, understand an event sequence within an identified time frame, and determine the degree to which one or more elements change over time and how the system functions generally over time.			
Level 1 (Score=0)	Level 2 (Score=1)	Level 3 (Score=2)	Level 4 (Score=3)
No or irrelevant response The child does not make any predictions related to the future behavior of the system. Example: "Then, the animals swim in the water".	*Limited Time Dimension* The child constructs her/his future predictions on the existing pattern. Example: "The water will be consumed by the animals again. The animals will go; then, the water will return, and the animals will come back".	*Broader Time Dimension* The child makes future predictions through seeing the issue from a wider perspective, s/he positions prediction in a larger time interval and makes predictions not only based on the existing pattern. Example: "Water will go away, come back, and go away again for some more time; then, it will be gone for good".	*Messes Perspective* The child grasps how sophisticated the dynamics of even a simple system actually is; so, s/he does not try to foresee how it will act. Example: "I am not sure because it is hard to know".

C: THE INSTRUMENT-BASED SUSTAINABILITY AND SYSTEMS THINKING INDICATORS LIST

1. Preschool Climate	
Quality Indicators	**How the evidence was collected**
1.1 Opportunities for administrators, teachers and parents to have a say and be involved in all issues and themes that affect them are supported by institutionalized participation structures *[46]	Administrator and Teacher Interview Protocol Questions: -Please describe the decision-making processes at this preschool -To what extent are administrators, teachers and parents actively involved in decision-making processes?
1.2 Adults act out democratic forms of conflict resolution in preschool. Negotiation and conflict resolution processes are fostered *	Administrator and Teacher Interview Protocol Questions: Do you think people in this preschool experience conflict situations in decision-making processes? If yes, could you describe how those conflicts are dealt with?
1.3 Children act out democratic forms of conflict resolution in the group. Negotiation and conflict resolution processes are fostered *	
1.4 Staff feedback and consultation sessions take place regularly *	Administrator and Teacher Interview Protocol Question: Do staff feedback and consultation sessions take place regularly?
1.5 In the preschool, there is a comprehensive approach to staff development and training	Administrator and Teacher Interview Protocol Question: What is being done in this preschool to develop teachers' personal and professional competencies?
1.6 The preschool works in close cooperation with	Administrator Interview

[46] * Retrieved from Transfer 21 Programme (2007). *Developing quality at "ESD Schools" quality areas, principles and criteria.* Berlin: Freie Universität Berlin.

** Retrieved from Hohmann, M., Weikart, D. P. & Epstein, A. S. (2008). *Educating young children: Active learning practices for preschool and child care programs (3rd ed.).* Ypsilanti, MI: High/Scope Press.

*** Retrieved from Massey, S. L. (2004). Teacher–Child Conversation in the Preschool Classroom. *Early Childhood Education Journal, (31)*4, 227-231.

Other items were created by the investigator of this research.

individuals, organizations and authorities outside the school in order to open up external spaces for experience and learning *	Protocol Question: Do you work collaboratively with individuals, organizations and authorities outside the school in order to open up external spaces for experience and learning?
2. Physical Space	
Quality Indicators	**How the evidence was collected**
2.1 Children have access to most parts of the indoor environment	Learning Environment Observation Protocol
2.2 Children have access to most parts of the outdoor environment	Learning Environment Observation Protocol
2.2 There are abundant materials that children can use in many ways **	Learning Environment Observation Protocol
2.4 Children have space to use the materials **	Learning Environment Observation Protocol
2.5 Children have time to use the materials **	Learning Environment Observation Protocol
2.6 Systems are illustrated in the learning environment	Learning Environment Observation Protocol
2.7 Children are able to see and touch the systems	Learning Environment Observation Protocol
3. Approach to Learning and Experiences	
Quality Indicators	**How the evidence was collected**
3.1 Learning experiences are linked with other learning experiences	Learning Experiences Observation Protocol
3.2 Subject-spanning is utilized *	Learning Experiences Observation Protocol
3.3 Project-based learning is utilized *	Learning Experiences Observation Protocol
3.4 A multidisciplinary approach is utilized	Learning Experiences Observation Protocol
3.5 An interdisciplinary approach is utilized	Learning Experiences Observation Protocol
3.6 Documentation enables the children to observe their own learning processes throughout time	Teacher Interview Protocol Question: How do you document children's learning and development experiences? Additional documents, such as a portfolio for each child
4. Thinking and Acting Routines	
Quality Indicators	**How the evidence was collected**
4.1 Adults ask cognitively challenging questions *** (If adults ask most level 1 and 2 type questions, the indicator is not fulfilled. If adults ask mostly level 2 and 3 type questions, the indicator is partially	Learning Experiences Observation Protocol

fulfilled. If adults ask mostly level 3 and 4 type questions, the indicator is fully fulfilled) Level 1: Matching perception focusing on the concrete aspects and involving labeling and locating objects or characters. (i.e., What is this?) Level 2: Selective analysis/integration of perception focusing on describing and recalling. (i.e., What ingredients did we use to make our snack this morning?) Level 3: Reordering or inferring about perception dealing with summarizing, defining, comparing and contrasting, and providing judgments. (i.e., Why did he feel that way?) Level 4: Reasoning about perception involving predictions, problem solving, and concept explanation. (i.e., How do you think the mice will attempt to escape from the snake? Do you think it will work? What else can they do? Explain how the machine you built works.)	
4.2 Children can talk freely **	Learning Experiences Observation Protocol
4.3 Children were let to ask questions **	Learning Experiences Observation Protocol
4.4 Adults create opportunities for a circle of viewpoints *	Learning Experiences Observation Protocol
4.5 Adults listen for and encourage children's thinking **	Learning Experiences Observation Protocol
4.6 Adults create open-ended experiences to foster creativity	Learning Experiences Observation Protocol
4.7 Adults focus on individual children or creates small groups for deeper understanding **	Learning Experiences Observation Protocol
4.8 There are wrap-up or reflection exercises at the end of the activities	Learning Experiences Observation Protocol
4.9 Adults display flexibility when creating learning opportunities *	Learning Experiences Observation Protocol
4.10 Adults provide children with the space to participate in decision-making processes in line with their age and abilities *	Learning Experiences Observation Protocol
4.11 Adults encourage children to do things for themselves **	Learning Experiences Observation Protocol
4.12 Free play is extensively encouraged by adults	Learning Experiences Observation Protocol
5. Further Focus on Sustainability	
Quality Indicators	**How the evidence was collected**
5.1 Theories and concepts of sustainability are used to reflect upon everyday knowledge and actions *	Holistic evaluation of data collected via all instruments
5.2 Sustainability topics are integrated into internal preschool teaching plans and curricula *	Holistic evaluation of data collected via all instruments
5.3 Adults in the case received pre- and in-service training in the field of ESD, EE and EfS *	Administrator and Teacher Interview Protocol Question:

	Did you receive environmental education, sustainability, education for sustainable development-related pre- and in-service training?
5.4 Purchasing policies for supplies, equipment and food are based in equal measure upon environmental and social sustainability and on economic viability *	Administrator Interview Protocol Question: Are there any criteria regarding the purchase of goods and materials for school use? (Educational materials, food, cleaning materials, stationary, etc.)
5.5 Resources are carefully managed by reducing, reusing and recycling	Learning Environment Observation Form and Administrator Interview Protocol Question: Which strategies are put in place for the reuse, reduce, recycle and disposal of resources?
5.6 Adults provide the definition of the term "diversity" in a multi-dimensional way	Administrator and Teacher Interview Protocol Question: What comes to your mind when I say diversity? Do you somehow focus on diversity issues in this learning environment? If yes, how?
5.7 Adults shows acceptance of people in their differences *	Learning Experiences Observation Protocol
5.8 Adults provide children with the opportunity to learn, appreciate and compare cultural diversity *	Learning Experiences Observation Protocol
5.9 Adults provide children with the opportunity to learn, appreciate and compare diversity in nature *	Learning Experiences Observation Protocol
6. Systems Thinking Aspects	
Quality Indicators	**How the evidence was collected**
6.1 There are educational materials concerning the use of mathematical reasoning exercises such as numeration, pattern building and discrimination of size	Learning Environment Observation Protocol
6.2 Children practice mathematical reasoning experiences such as numeration, pattern building and discrimination of size	Learning Experiences Observation Protocol
6.3 Children are engaged in one-way causality building experiences	Learning Experiences Observation Protocol
6.4 Children are engaged in closed-loop thinking practices	Learning Experiences Observation Protocol
6.5 Adults and/or children use sentences with following phrases: "the more, the more" "the less,	Learning Experiences Observation Protocol

the less" "the more, the less" "the less, the more"	
6.6 Adults ask questions such as "what was this story about?" and "give a title to the book" during the book reading activities	Learning Experiences Observation Protocol
6.7 There are conversations about how systems work	Learning Experiences Observation Protocol
6.8 Adults and children discuss about what would happen if a component was added to or removed from a system	Learning Experiences Observation Protocol
6.9 Children were let to encounter real-life problems **	Learning Experiences Observation Protocol
6.10 Adults provide opportunities for children to solve problems on their own	Learning Experiences Observation Protocol
6.11 There are conversations about hidden components and processes in systems	Learning Experiences Observation Protocol
6.12 There are conversations about root causes	Learning Experiences Observation Protocol
6.13 Subject-matter knowledge is very important in this learning environment	Learning Experiences Observation Protocol
6.14 Children were engaged in imagination practices	Learning Experiences Observation Protocol
6.15 Children become involved in conversations related to time	Learning Experiences Observation Protocol
6.16 Children become involved in conversation related to past-present-future connection	Learning Experiences Observation Protocol
6.17 Children become involved in conversations related to future-prediction	Learning Experiences Observation Protocol

D: THE SUSTAINABILITY AND SYSTEMS THINKING INDICATORS CHECKLIST

1. Preschool Climate	**No**	**Partially**	**Yes**
1.1 Opportunities for administrators, teachers and parents to have a say and be involved in all issues and themes that affect them are supported by institutionalized participation structures *			
1.2 Adults act out democratic forms of conflict resolution in preschool. Negotiation and conflict resolution processes are fostered *			
1.3 Children act out democratic forms of conflict resolution in the group. Negotiation and conflict resolution processes are fostered *			
1.4 Staff feedback and consultation sessions take place regularly *			
1.5 In the preschool, there is a comprehensive approach to staff development and training			
1.6 The preschool works in close cooperation with individuals, organizations and authorities outside the school in order to open up external spaces for experience and learning *			
2. Physical Space	**No**	**Partially**	**Yes**
2.1 Children have access to most parts of the indoor environment			
2.2 Children have access to most parts of the outdoor environment			
2.3 There are abundant materials that children can use in many ways **			
2.4 Children have space to use the materials **			
2.5 Children have time to use the materials **			
2.6 Systems are illustrated in the learning environment			
2.7 Children are able to see and touch the systems			
3. Approach to Learning and Experiences	**No**	**Partially**	**Yes**
3.1 Learning experiences are linked with other learning experiences			
3.2 Subject-spanning is utilized *			
3.3 Project-based learning is utilized *			
3.4 A multidisciplinary approach is utilized			
3.5 An interdisciplinary approach is utilized			
3.6 Documentation enables the children to observe their own learning processes throughout time			
4. Thinking and Acting Routines	**No**	**Partially**	**Yes**
4.1 Adults ask cognitively challenging questions ***			
4.2 Children can talk freely **			
4.3 Children were let to ask questions **			
4.4 Adults create opportunities for a circle of viewpoints *			
4.5 Adults listen for and encourage children’s thinking **			
4.6 Adults create open-ended experiences to foster creativity			
4.7 Adults focus on individual children or creates small groups			

for deeper understanding **			
4.8 There are wrap-up or reflection exercises at the end of the activities			
4.9 Adults display flexibility when creating learning opportunities *			
4.10 Adults provide children with the space to participate in decision-making processes in line with their age and abilities *			
4.11 Adults encourage children to do things for themselves **			
4.12 Free play is extensively encouraged by adults			
5. Focus on Sustainability	**No**	**Partially**	**Yes**
5.1 Theories and concepts of sustainability are used to reflect upon everyday knowledge and actions *			
5.2 Sustainability topics are integrated into internal preschool teaching curricula *			
5.3 Adults in the case received pre and/or in-service trainings in the field of ESD, EE and EfS *			
5.4 Purchasing policies for supplies, equipment and food are based in equal measure upon environmental and social sustainability and on economic viability *			
5.5 Resources are carefully managed by reducing, reusing and recycling			
5.6 Adults provide the definition of the term “diversity” in a multi-dimensional way			
5.7 Adults shows acceptance of people in their differences *			
5.8 Adults provide children with the opportunity to learn, appreciate and compare cultural diversity *			
5.9 Adults provide children with the opportunity to learn, appreciate and compare diversity in nature *			
6. Systems Thinking Aspects	**No**	**Partially**	**Yes**
6.1 There are educational materials concerning the use of mathematical reasoning exercises such as numeration, pattern building and discrimination of size			
6.2 Children practice mathematical reasoning experiences such as numeration, pattern building and discrimination of size			
6.3 Children are engaged in one-way causality building experiences			
6.4 Children are engaged in closed-loop thinking practices			
6.5 Adults and/or children use sentences with following phrases: “the more, the more” “the less, the less” “the more, the less” “the less, the more”			
6.6 Adults ask questions such as “what was this story about?” and “give a title to the book” during the book reading activities			
6.7 There are conversations about how systems work			
6.8 Adults and children discuss about what would happen if a component was added to or removed from a system			
6.9 Children were let to encounter real-life problems			
6.10 Adults provide opportunities for children to solve problems on their own			
6.11 There are conversations about hidden components and processes in systems			
6.12 There are conversations about root causes			
6.13 Subject-matter knowledge is very important in this learning environment			

6.14 Children were engaged in imagination practices			
6.15 Children become involved in conversations related to time			
6.16 Children become involved in conversation related to past-present-future connection			
6.17 Children become involved in conversations related to future-prediction			

* Retrieved from Transfer 21 Programme. (2007). *Developing quality criteria at ESD schools, quality areas, principles and criteria. Berlin*: Freie Universität Berlin.

** Retrieved from Hohmann, M., Weikart, D. P. & Epstein, A. S. (2008). *Educating young children: Active learning practices for preschool and child care programs (3rd ed.).* Ypsilanti, MI: High/Scope Press.

*** Retrieved from Massey, S. L. (2004). Teacher–Child Conversation in the Preschool Classroom. *Early Childhood Education Journal, (31)*4, 227-231.

Other items were created by the investigator of this research.

E: THE TEACHER INTERVIEW PROTOCOL

Name of the Case: Initials of the Teacher:

Date: Start Time: End Time:

Dear Participant, this interview will help us to understand this educational context in detail. The interview will take around 20 minutes to complete. Your responses will be anonymous and confidential. Thank you for being part of this study, your cooperation is greatly appreciated.

A. Getting Know the Context

1. Could you explain the pedagogical concept of this preschool?

    1.1 How is this pedagogical concept of the preschool being applied to the learning experiences of children?

2. What are the main developmental areas that are being focused in this learning environment?

3. Please, describe the decision-making processes at this preschool.

    3.1 To what extent are administrators, teachers and parents actively involved in decision-making processes?

    3.2 Do you think people in this preschool experience conflict situations in decision-making processes? If yes, could you describe how those conflicts are dealt with?

4. Do staff feedback and consultation sessions take place regularly?

5. As the teacher of this learning group, which skills of your students you try to develop most?

6. How do you document children’s learning and development experiences?

7. Have you conducted any activities on water cycle, population, and animal migration with this learning group?

B. Focus on Sustainability

1. What comes to your mind when I say diversity?

    1.1 Do you somehow focus on diversity issues in this learning environment? If yes, how?

2. What comes to your mind when I say sustainability?

    2.1 Are principles and concepts of sustainability being integrated into the learning experiences of children? If yes, how?

C. Pre and In-service Teacher Training

1. Could you describe the main courses you took during your pre-service teacher training?
2. Did you receive environmental education, sustainability, education for sustainable development related courses at that time?
3. What is being done in this preschool to develop teachers' personal and professional competencies?
4. Could you describe the main topics of the in-service trainings you have been participating?
5. Did you receive environmental education, sustainability, education for sustainable development related in-service trainings throughout your profession?

D. Getting Know the Teacher

1. Gender of the person: ( )F ( )M
2. How old are you?
3. What is the level of your education?
4. When did you start your profession as a preschool teacher?

So, you have an experience of ……… years as a preschool teacher.

5. Since when are you working at this preschool?
6. Since when is this particular group under your supervision?
7. Do you have any questions?

Thank you very much for your contribution

F: THE PRESCHOOL ADMINISTRATOR INTERVIEW PROTOCOL

Name of the Case: Initials of the Preschool Administrator:

Date: Start Time: End Time:

Dear Participant, this interview will help us to understand this educational context in detail. The interview will take around 25 minutes to complete. Your responses will be anonymous and confidential. Thank you for being part of this study, your cooperation is greatly appreciated.

A. Getting Know the Context

1. Could you explain the pedagogical concept of this preschool?

    1.1 How is this pedagogical concept of the preschool being applied to the learning experiences of children?

2. What are the main developmental areas that are being focused in this learning environment?

3. Please, describe the decision-making processes at this preschool.

    3.1 To what extent are administrators, teachers and parents actively involved in decision-making processes?

    3.2 Do you think people in this preschool experience conflict situations in decision-making processes? If yes, could you describe how those conflicts are dealt with?

4. To what extent are you involved with the learning experiences of children?

5. Do staff feedback and consultation sessions take place regularly?

6. Do you work collaboratively with individuals, organizations and authorities outside the school in order to open up external spaces for experience and learning?

7. What are the financial resources of the school?

8. Could you explain main socio-demographic characteristics of parents of the learning group that is part of the thesis study?

9. Could you explain the numbers and characteristics of the staff in this preschool?

B. Focus on Sustainability and Systems Thinking

1. What comes to your mind when I say diversity?

    1.1 Do you somehow focus on diversity issues in this learning environment? If yes, how?

2. What comes to your mind when I say sustainability?

2.1 Are principles and concepts of sustainability being integrated into the learning experiences of children? If yes, how?

3. Are there any criteria regarding the purchase of goods and materials for school use? (Educational materials, food, cleaning materials, stationary, etc.)

4. Which strategies are put in place for the reuse, reduce, recycle and disposal of resources?

C. Pre and In-service Teacher Training

1. Could you describe the main courses you took during your pre-service teacher training?

2. Did you receive environmental education, sustainability, education for sustainable development related courses at that time?

3. What is being done in this preschool to develop teachers' personal and professional competencies?

4. Could you describe the main topics of the in-service trainings you have been participating?

5. Did you receive environmental education, sustainability, education for sustainable development related in-service trainings throughout your profession?

D. Getting Know the Preschool Administrator

1. Gender of the person: ( )F   ( )M

2. How old are you?

3. What is the level of your education?

4. When did you start your profession as a preschool administrator?

So, you have an experience of ……… years as a preschool administrator.

5. Since when are you working at this preschool?

6. Do you have any questions?

Thank you very much for your contribution

G: THE LEARNING EXPERIENCES OBSERVATION PROTOCOL

Observer: Reliability Observer:

Group Name: Number of Observation:

Date: Start Time: End Time:

A-General Characteristics of the Learning Experiences

Number of children in the case:

Number of adults assigned to the case:

Characteristics of the adults assigned to the case (such as specialty areas, working hours etc.):

Daily flow of the case:

B-Quality Indicators	**No**	**Partially**	**Yes**	**Field Notes**	**Non-Observed Things**
Learning experiences are linked with other learning experiences					
Subject-spanning is utilized					
Project-based learning is utilized					
A multidisciplinary approach is utilized					
An interdisciplinary approach is utilized					
Adults ask cognitively challenging questions					
Children can talk freely					
Children were let to ask questions					
Adults create opportunities for a circle of viewpoints					
Adults listen for and encourage children's thinking					
Adults create open-ended experiences to foster creativity					
Adults focus on individual children or					

creates small groups for deeper understanding					
There are wrap-up or reflection exercises at the end of the activities					
Adults display flexibility when creating learning opportunities					
Adults provide children with the space to participate in decision-making processes in line with their age and abilities					
Adults encourage children to do things for themselves					
Free play is extensively encouraged by adults					
Adults shows acceptance of people in their differences					
Adults provide children with the opportunity to learn, appreciate and compare cultural diversity					
Adults provide children with the opportunity to learn, appreciate and compare diversity in nature					
Children practice mathematical reasoning experiences such as numeration, pattern building and discrimination of size					
Children are engaged in one-way causality building experiences					
Children are engaged in closed-loop thinking practices					
Adults and/or children use sentences with following phrases: “the more, the more” “the less, the less” “the more, the less” “the less, the more”					
Adults ask questions such as “what was this story about?” and “give a title to the book” during the book reading activities					
There are conversations about how systems work					

Adults and children discuss about what would happen if a component was added to or removed from a system					
Children were let to encounter real-life problems					
Adults provide opportunities for children to solve problems on their own					
There are conversations about hidden components and processes in systems					
There are conversations about root causes					
Subject-matter knowledge is very important in this learning environment					
Children were engaged in imagination practices					
Children become involved in conversations related to time					
Children become involved in conversation related to past-present-future connection					
Children become involved in conversations related to future-prediction					

C- Other Characteristics of the Learning Experiences

Documentation techniques utilized in the case:

Other special aspects of the learning experiences:

H: THE LEARNING ENVIRONMENT OBSERVATION PROTOCOL

Observer: Reliability Observer: Group Name:
Date: Start Time: End Time:

A-General Characteristics of the Learning Environment
The size of the indoor area in terms of m^2**:**

Description of the indoor area:

The size of the outdoor area in terms of m^2:

Description of the outdoor area**:**

B-Quality Indicators	**No**	**Partially**	**Yes**	**Field Notes**	**Non-Observed Things**
Children have access to most parts of the indoor environment					
Children have access to most parts of the outdoor environment					
There are abundant materials that children can use in many ways					
Children have space to use the materials					
Children have time to use the materials					
Systems are illustrated in the learning environment					
Children are able to see and touch the systems					
Resources are carefully managed by reducing, reusing and recycling					
There are educational materials concerning the use of mathematical reasoning exercises such as numeration, pattern building and discrimination of size					

C- Other Characteristics of the Learning Environment

Topics of the wall displays are:

Materials for children to be engaged are:

General conclusions about the books present (such as number of books, topic of the books):

Map of the indoor learning environment:

Map of the outdoor learning environment:

Other special aspects of the learning environment:

I: THE INFORMED CONSENT FORM

ARAŞTIRMAYA GÖNÜLLÜ KATILIM FORMU

Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir?

Araştırmanın amacı 4-6 yaş grubundaki çocukların sistem düşüncesi becerilerini oluşturma süreçlerini ortaya koymak ve bu beceri ile eğitim bağlamları arasındaki etkileşimi incelemektir.

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz?

Araştırmaya katılmayı kabul ederseniz, sizden bir anket doldurmanız ve bireysel gerçekleşecek olan mülakata katılmanız beklenmektedir. Anket yaklaşık 10 dakikada doldurulmakta, mülakat ise yaklaşık 20 ila 30 dakika sürmektedir. Daha sonra içerik analizi ile değerlendirilmek üzere mülakatta vereceğiniz cevapların ses kaydı alınacaktır.

Sizden Topladığımız Bilgileri Nasıl Kullanacağız?

Araştırmaya katılımınız tamamen gönüllülük temelinde olmalıdır. Çalışmada sizden kimlik veya kurum belirleyici hiçbir bilgi istenmemektedir. Cevaplarınız tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir. Katılımcılardan elde edilecek bilgiler toplu halde değerlendirilecek ve bilimsel yayımlarda kullanılacaktır.

Katılımınızla ilgili bilmeniz gerekenler:

Anket ve mülakat içerikleri rahatsızlık verecek sorular içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz çalışmayı yarıda bırakmakta serbestsiniz. Böyle bir durumda çalışmayı yürüten kişiye çalışmadan çıkmak istediğinizi söylemeniz yeterli olacaktır.

Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Anket ve mülakat uygulamaları sonunda bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz.

Araştırmayla ilgili sorularınızı aşağıdaki iletişim bilgilerini kullanarak yöneltebilirsiniz.

	Tez Danışmanı:	Ortak Tez Danışmanı:
Şebnem FERİVER GEZER	Doç. Dr. Refika OLGAN	Prof. Dr. Gaye TEKSÖZ
0163 741 24 76	0312 210 36 71	0312 210 64 11
sebnemferiver@gmail.com	rolgan@metu.edu.tr	gtuncer@metu.edu.tr

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.

(Formu doldurup imzaladıktan sonra araştırmacıya geri veriniz).

İsim Soyisim	Tarih	İmza
	---/----/-----	

ANMELDEFORMULAR: FREIWILLIGE TEILNAHME AN DEM FORSCHUNGSPROJEKT

Dieses Formular wurde vorbereitet, um Sie über die Bedingungen des Forschungsprojektes zu informieren.

Was ist das Ziel dieser Studie?

Der Zweck der Forschung ist, die Entwicklungsprozesse des systematischen Denkvermögens von 5-jährigen Kindern festzulegen, um die Wechselwirkung zwischen diesen Fähigkeiten und der Bildung zu untersuchen.

Wie können Sie uns helfen?

Wenn Sie einverstanden sind, an dieser Forschung teilzunehmen, würden wir Sie bitten, dass Sie dieses Umfrageformular ausfüllen und an einem Einzelgespräch teilnehmen. Für das Ausfüllen des Formulars werden Sie voraussichtlich nicht mehr als 10 Minuten benötigen, das Gespräch dauert etwa 20 bis 30 Minuten. Das Gespräch wird zwecks einer späteren detaillierten Analyse aufgenommen. Die Auswertung erfolgt in Kombination mit dem Fragebogen, aber ohne Bezug auf persönliche Daten wie Name, Adresse oder Geburtsdatum (folgender Abschnitt).

Wie werden wir die Informationen, die wir von Ihnen erhalten haben, verwenden?

Ihre Teilnahme an der Forschung muss vollständig auf freiwilliger Basis geschehen. Während der Studie werden von Ihnen keinerlei Personenangaben oder entscheidende Unternehmensinformationen verlangt. Ihre Antworten werden komplett vertraulich behandelt und nur von den Forschern ausgewertet. Die von den Teilnehmer/innen erhaltenen Informationen werden in Chargen (in Gruppen?) ausgewertet und in wissenschaftlichen Veröffentlichungen verwendet.

Was Sie über Ihre Teilnahme wissen sollten:

In der Umfrage und im Gespräch sind keine störenden Fragen enthalten. Falls Sie sich jedoch während der Teilnahme aufgrund von Ihnen als unangemessen empfundenen Fragen oder aus einem anderen Grund unwohl fühlen, können Sie die Studie zu jeder Zeit abbrechen. In einem solchen Fall ist es ausreichend, wenn Sie der Person, welche die Studie durchführt, mitteilen, dass Sie die Studie beenden wollen.

Wenn Sie mehr Informationen über die Forschung erhalten möchten:

Am Ende der Umfrage und dem Gespräch werden Ihre Fragen bezüglich dieser Studien beantwortet. Vielen Dank im Voraus für die Teilnahme an dieser Studie.

Sie können Ihre Fragen in Bezug auf die Forschung mit Hilfe der folgenden Kontaktinformationen stellen.

Sebnem FERİVER GEZER   Assoc. Prof. Dr. Refika OLGAN   Prof. Dr. Gaye TEKSÖZ

0163 741 24 76	+90 312 210 36 71	+90312 210 64 11
sebnemferiver@gmail.com	rolgan@metu.edu.tr	gtuncer@metu.edu.tr

Ich habe die obigen Informationen gelesen und stimme vollständig dieser Studie freiwillig zu.

(Bitte übergeben Sie einem unserer beteiligten Mitarbeiter dieses Formular, nachdem Sie es vollständig ausgefüllt und unterschrieben haben).

Name, Vorname	Datum	Unterschrift
	---/----/-----	

J: THE PARENT PERMISSION FORM

EBEVEYN İZİN MEKTUBU

Sayın Ebeveynler,

Orta Doğu Teknik Üniversitesi Eğitim Fakültesi Okul Öncesi Eğitim Bölümü'nde Jean Monnet Burs Programı tarafından desteklenmekte olan doktora tez çalışmamı yürütmekteyim. Çalışmam kapsamında çocuğunuzun devam ettiği anaokulunda mülakat ve gözlem çalışmaları yapmayı planlamaktayım.

Bu çalışmanın amacı nedir? Araştırmamızın amacı çocukların sistem düşüncesi becerilerini oluşturma süreçlerini ortaya koymak ve bu beceri ile eğitim bağlamları arasındaki etkileşimi incelemektir.

Sizin ve çocuğunuzun katılımcı olarak ne yapmasını istiyoruz?: Çalışmanın amacını gerçekleştirebilmek için çocuklarla yaklaşık 15 dakika sürecek bireysel bir mülakat yapmaya ihtiyaç duymaktayız. Mülakat içeriğinde çocuğunuza kısa bir öykü okuyacağız, ardından bu öyküdeki mevzuları derinlemesine inceleyeceğiz. Katılmasına izin verdiğiniz takdirde çocuğunuzla mülakatı okulda bulunduğu zaman aralığında gerçekleştireceğiz. Sizden çocuğunuzun katılımcı olmasıyla ilgili izin istediğimiz gibi, çalışmaya başlamadan önce de çocuğunuzdan sözlü olarak katılımıyla ilgili rızasını mutlaka alacağız.

Çocuğunuzdan alınan bilgiler ne amaçla ve nasıl kullanılacak?: Çocuğunuzla gerçekleştireceğimiz mülakatta aldığımız cevaplar kesinlikle gizli tutulacak ve bu cevaplar sadece bilimsel araştırma amacıyla kullanılacaktır. Çocuğunuzun ismi ve kimlik bilgileri hiçbir şekilde kimseyle paylaşılmayacaktır. Araştırma sonuçlarının özeti tarafımızdan okula ulaştırılacaktır. Çocuklarla gerçekleştireceğimiz bu çalışma çocukların sistem düşüncesi becerilerinin gelişmesini etkileyen faktörlerin saptanmasına önemli bir katkıda bulunacaktır.

Çocuğunuzun çalışmayı yarıda kesmesini isterseniz ne yapmalısınız?: Çocuğunuzun cevaplayacağı soruların onun psikolojik gelişimine olumsuz etkisi olmayacağından emin olabilirsiniz. Yine de, bu formu imzaladıktan sonra çocuğunuzun katılımcılıktan ayrılma hakkına sahiptir. Katılım sırasında sorulan sorulardan ya da herhangi bir uygulama ile ilgili başka bir nedenden ötürü çocuğunuz kendisini rahatsız hissettiğini belirtirse, ya da kendi belirtmese de araştırmacı çocuğun rahatsız olduğuna kanaat getirirse, çalışmaya sorular tamamlanmadan ve derhal son verilecektir. Şayet siz çocuğunuzun rahatsız olduğunu hissederseniz, böyle bir durumda bize çocuğunuzun çalışmadan ayrılmasını istediğinizi söylemeniz yeterli olacaktır.

Bu çalışmayla ilgili daha fazla bilgi almak isterseniz: Araştırmayla ilgili sorularınızı aşağıdaki iletişim bilgilerini kullanarak yöneltebilirsiniz.

Saygılarımızla,

	Tez Danışmanı:	Ortak Tez Danışmanı:
Şebnem FERİVER GEZER	Doç. Dr. Refika OLGAN	Prof. Dr. Gaye TEKSÖZ
0532 364 15 75	0312 210 36 71	0312 210 64 11
sebnemferiver@gmail.com	rolgan@metu.edu.tr	gtuncer@metu.edu.tr

Lütfen bu araştırmaya katılmak konusundaki tercihinizi aşağıdaki seçeneklerden size en uygun gelenin altına imzanızı atarak belirtiniz ve bu formu çocuğunuzla okula geri gönderiniz.

A) Bu araştırmaya çocuğum ....’nın da katılımcı olmasına izin veriyorum. Çocuğumun çalışmayı istediği zaman yarıda kesip bırakabileceğini biliyorum ve çocuğumun bilgilerinin bilimsel amaçlı kullanılmasını kabul ediyorum.

Ebeveyn Adı-Soyadı..................................

İmza ....

B) Çocuğum ....’nın da katılımcı olmasına izin vermiyorum.

Ebeveyn Adı-Soyadı..................................

İmza ....

EINWILLIGUNGERKLÄRUNG DER ELTERN

Sehr geehrte Damen und Herren, liebe Eltern,

Mein Name ist Sebnem FERIVER GEZER. Ich bin Doktorandin im Bereich Pädagogik. Das aktuelle Projekt beinhaltet Forschungen in Zusammenarbeit mit der Technischen Universität des Nahen Ostens, Fakultät für Pädagogik, und der Leuphana Universität, Fakultät für Nachhaltigkeit. Meine Forschungen zur Doktorarbeit werden von dem Stipendienprogramm Jean Monnet der Europäischen Union unterstützt.

Im Umfang meiner Forschung führen wir für 5 Tage zusammen mit meinen Forschungspartnern in Kindergärten mit verschiedenen Profilen in der Türkei und in Deutschland Beobachtungen und Gespräche mit Kindern durch. Zusätzlich soll es mit den Erzieher/innen und den Leitungen der Einrichtungen Gespräche geben, um uns über den Zusammenhang der Kinder mit Bildung (den Bildungsstand der Kinder) intensiv zu erkundigen.

Was ist das Ziel dieser Studie? Der Zweck der Forschung ist, die Entwicklungsprozesse des systematischen Denkvermögens von Vorschulkindern zu bestimmen, um die Wechselwirkung zwischen diesen Fähigkeiten und Bildung zu untersuchen.

Was möchten wir von Ihnen und Ihrem Kind als Teilnehmer? Wir führen Einzelgespräche mit den Kindern, die etwa 15 Minuten dauern. Innerhalb des Gespräches werden wir Ihrem Kind eine kurze Geschichte vorlesen, danach werden wir den Inhalt dieser Geschichte zusammen mit Ihrem Kind detailliert untersuchen. Falls Sie der Beteiligung Ihres Kindes zustimmen, werden wir das Gespräch mit Ihrem Kind innerhalb des Zeitraumes, in dem sich Ihr Kind im Kindergarten befindet, durchführen. Genau wie wir von Ihnen die Zustimmung für die Teilnahme Ihres Kindes einholen, werden wir selbstverständlich vor Beginn der Studie auch eine mündliche Einwilligung Ihres Kindes für die Beteiligung einholen.

Wie und zu welchem Zweck werden die Informationen, die wir von Ihrem Kind erhalten, verwendet? Die Antworten, welche wir innerhalb der Studie von Ihrem Kind erhalten, werden absolut vertraulich behandelt und nur für wissenschaftliche Forschungszwecke eingesetzt. Der Name, die persönlichen Informationen Ihres Kindes und der Name des Kindergartens werden nicht veröffentlicht. Die zusammengefassten Forschungsergebnisse werden nach Abschluss der Studienanalyse dem Kindergarten als Rückmeldung zugesendet.

Kann Ihr Kind die Studie zu jeder Zeit beenden? Sie können sich darauf verlassen, dass die Geschichte, die Ihrem Kind vorgelesen wird und die Fragen, die Ihr Kind beantworten wird, keine negativen Auswirkungen auf die Entwicklung Ihres Kindes haben. Die Geschichte und die dazu gehörigen Fragen wurden von der Ethikkommission für geeignet befunden, so dass sie keinerlei negative Auswirkungen auf die Kinder haben. Falls Ihr Kind sich während der Teilnahme aufgrund der Fragen oder aus irgend einem anderen Grund unwohl fühlt und uns mitteilt, dass es sich nicht wohl fühlt, oder falls die wissenschaftlichen Mitarbeiter auch ohne Mitteilung des Kindes denken, dass es sich nicht wohlfühlt, wird die Studie sofort beendet, ohne die Fragen komplett abzuschließen. Ihrem Kind wird vor Beginn der Studie am Anfang des Gespräches mitgeteilt, dass es zu jeder Zeit die Studie abbrechen kann.

Sie können Ihre Fragen in Bezug auf die Forschung mit Hilfe der folgenden Kontaktinformationen stellen.

Mit freundlichen Grüßen,

Sebnem FERİVER GEZER	Assoc. Prof. Dr. Refika OLGAN	Prof. Dr. Gaye TEKSÖZ
0163 741 24 76	+90 312 210 36 71	+90 312 210 64 11
sebnemferiver@gmail.com	rolgan@metu.edu.tr	gtuncer@metu.edu.tr

Unten sind mehrere Möglichkeiten für die Teilnahme aufgeführt. Bitte unterschreiben Sie die für Sie geeignete Option in Bezug auf die Teilnahme in dieser Forschung und übergeben Sie dieses Formular an die Kita.

A) Ich stimme zu, dass mein Kind ....an dieser Forschung teilnimmt. Ich weiß, dass mein Kind zu jeder Zeit die Studie abbrechen kann. Ich akzeptiere, dass die Informationen meines Kindes für wissenschaftliche Zwecke benutzt werden.

Name-Nachname der Eltern..

Unterschrift ....

B) Ich stimme nicht zu, dass mein Kind .... an dieser Forschung teilnimmt.

Name-Nachname der Eltern..

Unterschrift ....

K: VITA

PERSONAL INFORMATION

Surname, Name: Feriver Gezer, Şebnem
Nationality: Turkish (TC)
Date and Place of Birth: 20.09.1979, Tahran
Marital Status: Married
Phone: +90 532 364 15 75
email: sebnemferiver@gmail.com

EDUCATION

Degree	Institution	Year of Graduation
MS	METU Early Childhood Education	2010
BA	Boğaziçi University Political Science and International Relations	2002
High School	Kartal Anadolu High School, İstanbul	1997

WORK EXPERIENCE

Year	Organization	Position
2012- Present	UNICEF Country Office Turkey	Freelance Consultant
2011-Present	Turkish National Agency, Center for European Union Education and Youth Programmes	Independent External Evaluator
2008-2010	Öğretmen Akademisi Vakfı	Project Coordinator and Senior Trainer
2005-2008	The Regional Environmental Center Country Office Turkey	Project Manager

FOREIGN LANGUAGES

Advanced English, Intermediate German

PUBLICATIONS

Feriver-Gezer, Ş. (2016). Yeni nesil çocuğun nitelikli öğrenmesi için disiplinlerle, meslektaşlarla ve aileyle dayanışma. In G. Günaltay (Ed.) *Eğitim ve Kültürlerarası Diyalog* (pp.47-53). Berlin: BAU International Berlin.

Feriver, Ş., (Tuncer) Teksöz, G., Olgan, R. & Reid, A. (2015). Training early childhood teachers for sustainability: towards a ‘learning experience of a different kind’, *Environmental Education Research, 22*(5), 717-746.

Feriver, Ş. (2010). *Integrating Sustainability into Early Childhood Education through In-service Training: An Effort towards Transformative Learning.* Unpublished master's thesis, Middle East Technical University, Ankara.

Öğrenen Lider Öğretmen Eğitim Programı (2009). *Guidebooks for Teachers and Teacher Trainers.* Teacher's Academy Foundation.

Eğitim Yöneticileri Geliştirme Programı (2009). *Guidebooks for School Administrators and Their Trainers.* Teacher's Academy Foundation.

Feriver, Ş. & Dinçel, D. (2007).Yeryüzüne Küçük İzler, *Yeşil Ufuklar Dergisi, Ocak-Mart,* http://www.rec.org.tr/files/YU09.pdf.

İlköğretim Çocukları ve Öğretmenleri için Yeşil Kutu Multimedya Eğitim Seti (2007). *Green Pack Multimedia Environmental Education Set for Elementary School Students and Their Teachers.* Regional Environmental Center.

L: TURKISH SUMMARY/TÜRKÇE ÖZET

1. Giriş

Gezegenimizin bugün karşı karşıya kaldığı; biyoçeşitliliğin azalması, kaynakların tükenmesi, gıda kıtlığı ve kronik beslenme yetersizliği gibi güncel sorunlar, belli bir tanıma uymayan, her zaman ve her yerde işe yarayan tek bir çözüme sahip olmayan, tamamıyla belirsiz ve birden çok paydaş arasında gerçekleşen çıkar çatışması içinde sıkışmış sıkıntılı sorunlar olarak adlandırılabilir. Bu meselelerin ortak özellikleri son derece karmaşık ve sistemik, belirsiz ve tartışmalı, acil ve varoluşsal olmalarıdır (Wals, 2015).

21. yüzyılın koşulları, mevcut ve gelecekteki problemlerin karmaşıklığı ile başa çıkmak üzere bireylerin bilgi ve becerilerin geliştirilmesini elzem kılmaktadır (Benson, 2007). Mevcut indirgemeci ve mekanistik düşünce biçimi, karmaşık sosyal, ekolojik ve ekonomik sorunların çok yönlü, akışkan ve gelişmekte olan doğasını algılama ve çözme açılarından yetersiz kalmaktadır (Goerner, 2007; Meyfroidt, 2013; Moore & Westley, 2011; Wulun, 2007). Küresel zorluklarla başa çıkarken, sistem unsurları ile bu sistem unsurlarının başka sistem unsurları ile etkileşimlerini inceleyen sistem düşüncesi yaklaşımının her geçen gün daha önem kazandığı görülmektedir (Boardman & Sauser, 2008). Disiplinler arası bir yaklaşım çerçevesinde oluşturulan sistem düşüncesi yaklaşımı, karmaşık ikilemlerin anlaşılmasını ve azaltılmasını kolaylaştırmak amacıyla oluşturulmuştur (Bosh, King, Herbohn, Russel & Smith, 2007; Fazey, 2010).

Sistem düşüncesi yaklaşımı alanında önemli olan ve sıkça atıfta bulunulan Forrester, Senge ve Sweeney'ye göre çocuklar doğal sistem düşünürleridir. Bahse konu kişiler bu yaklaşımın çocuklarda doğal bir şekilde var olduğunu deneysel çalışmalara dayandırmaksızın ileri sürmüştür. Bu iddialar, bu tez çalışmasını yürüten araştırmacıyı şüpheye sürüklemiştir. Zira, alanyazında çocukların üst düzey düşünme becerileri sergileme konusunda dikkate değer kısıtlılıklara sahip olduklarını gösteren çalışmalar mevcuttur. Kaldı ki, sistem düşüncesi yaklaşımı üst düzey düşünme becerisi olarak ele alınmaktadır. Bu bakımdan sistem düşüncesi yaklaşımının karmaşık yapısı da ele alındığında çocukların doğal sistem düşüncesi becerilerinin kavramsallaştırılması bakımından daha net çalışmalar ortaya konmasının gerekli olduğu düşünülmektedir. Nihayetinde, sistem düşüncesi alanında, özellikle erken çocukluk dönemindeki çocukları hedef alan deneysel çalışmaların yoksunluğu dikkat çekmektedir (LaVigne, 2009). Bu bakımdan, farklı eğitim erken çocukluk eğitsel bağlamlarında gerçekleştirilecek deneysel çalışmaların, küçük çocukların sistem düşüncesi becerilerinin doğasını anlamada ve bu beceri ile etkileşime girebilecek olan eğitsel değişkenler hakkında bir kavrayış elde etmede önemli katkılar sağlayabileceği düşünülmektedir.

Sistem düşüncesi yaklaşımının önemi, eğitim disiplini de dâhil olmak üzere farklı akademik ve uygulamalı alanlarda ele alınmaya devam edilmektedir. Sistem düşüncesi yaklaşımı kullanımının pedagojik rehberlik açısından olumlu sonuçlar sağladığı ileri sürülmektedir (Hammond, 2003; Senge, 1990; Senge, Aleiner, Roberts, Ross & Smith, 1994; Waddock, 2006) ve bu yaklaşım halihazırda eğitim ve okul geliştirme çabalarına entegre edilmektedir (Benson, 2007). Porter ve Cordoba'ya (2009) göre, sistem düşüncesi yaklaşımı, çocukların günümüzde çokça rastlanan sürdürülebilirlikle ilgili konularda var olan karmaşıklığı ve gerilimi anlamalarına ve değerlendirmelerine yardımcı olma konusunda yol gösterici olma potansiyeline sahiptir. Sistem düşüncesi becerilerinin karmaşık sorunların anlaşılmasını kolaylaştırdığı argümanı üzerine sistem dinamistleri arasında bir uzlaşı olduğu görülmektedir (Maani & Maharaj, 2004). Sistem odaklı eğitimin bu özelliği çevre eğitimi açısından çok önemlidir, çünkü çevresel sistemler karmaşıktır; sistem hareketlerinin ve bu hareketliliğin oluşturabileceği sonuçların tahmin edilmesi güçtür (Grant, 1998). Örüntüleri ve büyük resmi görmek, nitelikli bir gelecek inşa etme yönünde gerekli beceriler arasında sıralandıklarından (Pink, 2005) dolayı, çocukları sistem düşünürlerine dönüştürme hedefinin anlamlı bir girişim olduğu ileri sürülmektedir (Yates & Davidson, n.d.). Gerçekleştirilen sınıf uygulamaları, sistem düşüncesi yaklaşımının öğrencilerin eleştirel düşünme ve problem çözme becerilerini geliştirmelerine yardımcı olduğunu göstermiştir (Lyneis & Fox-Melanson, 2001). Sistem düşüncesi yaklaşımını uygulayan okullarda, öğrencilerin daha nitelikli sorular sordukları ve farklı konular boyunca örüntüleri ve bağlantıları tanımlayabildikleri bildirilmiştir. Ayrıca, Mandinach ve Cline (1989), sistem düşüncesi yaklaşımının hem kolay öğrenen hem de nispeten zor öğrenen öğrencilerde birlikte kullanılabileceği görüşünü desteklemektedir ve sistem yaklaşımının kullanılmasının daha yavaş öğrenen öğrenciler için umut verici sonuçlar doğurduğunu doğrulamaktadır.

Yukarıda da açıklandığı üzere, sistem düşüncesinin artı değeri ve faydası bir dizi akademisyen tarafından tanınmaktadır. Ancak bu alandaki deneysel araştırma miktarı özellikle okul öncesi düzeyinde oldukça yetersizdir (Delauzun & Mollona, 1999; Maani & Maharaj, 2004). İçinde bulunduğumuz yüzyılın karmaşıklığıyla başa çıkma bağlamında sistemin düşüncesinin önemi konusunda bir uzlaşma olmasına rağmen (Meadows & Wright, 2008; Plate, 2010; Senge, 1990), sistem düşüncesinin eğitime entegrasyonunun oldukça sınırlı bir düzeyde gerçekleştiği görülmektedir (Jacobson & Wilensky, 2006; Plate, 2010). Bu görüşü destekleyecek şekilde, birçok yazar, sistem düşüncesi araştırmalarının ve bu yaklaşımın öğretiminin henüz erken bir aşamada olduğunu iddia etmiştir (Forrester, 2007a, 2007b; Jacobsen & Wilensky, 2006; Wu, 2010; Yoon, 2008). Etkili sistem müdahalelerine ilişkin nicel kanıtlar sınırlıdır (Doyle, Radzicki & Trees, 1998). Bu nedenle, bu alanda deneysel çalışmalar yapmak suretiyle kanıtlar toplanması, bu kanıtlar doğrultusunda etkili müdahaleler geliştirilmesi gerekliliğinden söz edilmektedir (Skaza & Stave, 2010). Bu çerçeveden bakıldığında, bu çalışmada da olduğu gibi, farklı yaş gruplarından çocukların sistemsel düşünme becerilerini gerçek yaşam durumlarında araştırmanın anlamlı sonuçlar doğurabileceği düşünülmektedir. Bu görüşlerden yola çıkarak bu doktora araştırmasında iki katmanlı bir yapı kurgulanmıştır. İlk katmanda, 4 ila 6 yaş arasındaki okul öncesi çocuklarının sistemsel düşünme becerilerinin doğası kavramsallaştırılmıştır. Bu girişimin bulgularının, çocuklara yönelik oluşturulacak eğitim politikaları ve uygulamaları için önemli bir zemin hazırlayacağı düşünülmektedir. Bu amaç doğrultusunda araştırmaya dâhil edilen çocuk katılımcılar ile bireysel hikâye okuma çalışması yapılmış, hikâyedeki sistem davranışlarını irdelemeye yönelik bireysel görüşmeler gerçekleştirilmiştir. Dört ila 6 yaş arasındaki okul öncesi çocuklarının sistemsel düşünme becerileri, bu çalışmanın bir parçası olarak geliştirilen bir gelişimsel değerlendirme ölçeği kullanarak sistem düşüncesinin farklı yönleri bağlamında kavramsallaştırılmıştır.

Bu çalışmanın ikinci katmanı gereği, erken çocukluk eğitimi bağlamları ile çocukların sistemsel düşünme becerileri arasındaki ilişki ele alınmıştır. Çocukların sistemsel düşünme becerilerini geliştirmek amacıyla oluşturulabilecek eğitim politikalarına ve uygulamalarına ışık tutmaya yardımcı olma potansiyeline sahip eğitsel bağlam değişkenleri ortaya konmuştur. Bu hedefe ulaşmak adına iki farklı ülkede yer alan erken çocukluk eğitim bağlamları üzerinden bir kurgulama yapılmıştır. İki farklı ülkede yer alan eğitim bağlamlarında uygulamada olan farklı eğitsel sistemlerin, pedagojik uygulamaların çocukların sistemsel düşünme becerileri üzerindeki olası etkilerini ortaya koymak üzere karşılaştırmalı çoklu durum çalışması gerçekleştirilmiştir. Avrupa Birliği üye ülkesi olan Almanya ve Avrupa Birliği aday ülkesi olan Türkiye bu araştırma kapsamında üç farklı sebepten dolayı karşılaştırılmıştır. Bu sebeplerden ilki iki ülkenin ürettiği erken çocukluk eğitimi politikalarındaki farka dayandırılmaktadır, bu farkın özellikle erken çocukluk dönemindeki çocukların okul öncesi eğitime erişim zamanları ve süreleri bağlamında önemli sonuçlar doğurduğu düşünülmektedir. İkinci sebep, iki ülke arasındaki Sürdürülebilir Kalkınma (SK) ile Sürdürülebilir Kalkınma için Eğitim (SKE) politikalarına yaklaşım farklılıklarına dayanmaktadır. Üçüncü sebep, iki ülke arasındaki sistemsel düşünce yaklaşımı konusunda kaydedilen aşamalardaki farklılıklara dayanmaktadır. Bahsi geçen üç alanda da Almanya ile Türkiye oldukça farklı konumdadır. Bu zıtlıklar araştırma kapsamında kurgulanan karşılaştırmalı yaklaşımın temellerini oluşturmaktadır. Araştırmada ayrıca eğitim politikalarının sınıf içi uygulamalarına yansıması olan iki pedagojik yaklaşım arasında da karşılaştırma olanağı yakalanmıştır. İlk pedagojik yaklaşım gereği her iki ülkede de var olan eğitim yapılarını olabildiğince yansıtma özelliğine sahip, üniversite mezunu ebeveynlerin çocuklarının devam etmekte olduğu anaakım anaokulların prototipik değerini yansıtacak eğitsel bağlamlar seçilmiştir[47]. İkinci pedagojik yaklaşım gereği, sürdürülebilirlik yaklaşımı ile uyumlu ve anaakım eğitim yaklaşımlarına eleştirel bir çerçeveden bakan alternatif eğitim hizmeti sunan eğitsel bağlamlar ile çalışılmıştır. Anaakım ile alternatif pedagoji arasındaki zıtlığın yanı sıra sürdürülebilirlikle uyumlu kurgulanan pedagojik yapıların çocukların sistemsel düşünme becerilerini destekleyebileceği varsayımı (Center for Ecoliteracy, n.d.) bu tercihin yapılmasını mümkün kılmıştır.

Sonuç olarak, mevcut araştırmada, farklı eğitim politikalarının, pedagojik yaklaşımların ve uygulamaların okul öncesi çocuklarının sistemsel düşünme becerileri üzerindeki olası etkileri betimleyici ve karşılaştırmalı bir bakış açısı ile ele alınmıştır. Bu şekilde bu araştırmada, eğitim politikalarını oluşturanlar, akademisyenler, sürdürülebilirlik için erken çocukluk eğitimi araştırmacıları hedef alınarak çocuklara günümüzün karmaşık sorunlarını çözmelerine yardımcı olacak donanımı sağlamak amacıyla yenilikçi bir eğitsel anlayışın geliştirilmesi hedeflenmiştir.

Bu araştırmada ele alınan araştırma soruları şunlardır:

---

[47] Ebeveynlerin eğitim düzey, çocuğun bilişsel gelişimine etki eden en önde gelen değişkenlerden birisidir (Ardila, Rosselli, Matute & Guajardo, 2005). Yükseköğrenim görmüş ebeveynler çocukları için daha fazla entellektüel uyaran ortamlar sağlama eğilimindedir (Hoff, 2003a, 2003b). Bu argümanlar göz önüne alındığında, çalışmanın araştırmacısı, üniversite eğitimi olan ebeveynlerin çocukları ile çalışmaya karar vermiştir, zira sistemsel düşünme becerileri yüksek dereceli bilişsel beceriler kategorisinde yer almaktadır.

1. Türkiye'deki ve Almanya'daki 4-6 yaşlarındaki okul öncesi çocukların sistemsel düşünme becerilerinin düzeyi nedir?

1.1 Türkiye’deki ve Almanya'daki 4-6 yaşlarındaki okul öncesi çocuklarının sistemsel düşünme becerilerinin düzeyi çocukların yaşına, cinsiyetine, dil geçmişlerine ve ebeveyn eğitimi düzeylerine göre nasıl değişiklik göstermektedir?

2. Türkiye’deki ve Almanya’daki var olan eğitim bağlamları ile çocukların sistemsel düşünme becerilerinin farklı yönleri arasındaki etkileşim kalıpları nelerdir?

2.1 4-6 yaş grubundaki okul öncesi çocukların sistemsel düşünme becerileri seviyeleri ile Türkiye’deki ve Almanya’daki eğitsel bağlamlar arasındaki etkileşim kalıplarını tanımlayan değişkenler nelerdir?

3.1. Türkiye’den ve Almanya'dan seçilen anaakım ve alternatif durumlardaki 4-6 yaşlarındaki okul öncesi çocukların sistemsel düşünme becerilerinin düzeyi nedir?

3.2. Türkiye’den ve Almanya'dan seçilen anaakım ve alternatif durumların eğitsel bağlamlarının özellikleri nelerdir?

3. 3. Aşağıdakiler arasındaki benzerlikler ve farklılıklar nelerdir?:

3.3.1. Türkiye'den seçilen anaakım ve alternatif eğitim durumlarına karşı Almanya'dan seçilen anaakım ve alternatif eğitim durumları

3.3.2 Türkiye’den seçilen anaakım eğitim durumuna karşı Almanya’dan seçilen anaakım eğitim durumları

3.3.3 Türkiye’den seçilen alternatif eğitim durumuna karşı Almanya’dan seçilen alternatif eğitim durumu

2. Yöntem

2.1 Araştırma Yöntemi

Bu çalışmada, 4-6 yaşlarındaki okul öncesi çocuklarının sistemsel düşünme becerilerinin, Türkiye ve Almanya'daki farklı erken çocukluk eğitsel bağlamlarında nasıl kavramsallaştırılabileceğini ve bu eğitsel bağlamların bu becerinin oluşumunu nasıl etkilediğini ortaya koymak üzere karşılaştırmalı çoklu durum çalışması deseni kullanılmıştır. Bu seçimin ardında dört temel sebep yatmaktadır. İlk olarak, durum çalışması, mevcut bir olguyu (bu araştırmada, okul öncesi öğrencilerinin sistemsel düşünme becerileridir), özellikle de olgu ve bağlamı ayırmak zor olduğu durumlarda, gerçek yaşam bağlamında (bu araştırmada, okul öncesi eğitim bağlamlarında) inceleyen deneysel bir araştırma türüdür (Yin, 1994). Bu özelliğinden dolayı bu araştırmanın hedefleri ile seçilen desen tam anlamıyla birbiriyle örtüşmektedir. İkinci olarak, durum çalışmalarında, neyin niçin gerçekleştiğine dair bir açıklamaya ulaşılması hedeflenir

(Merriam, 1998). Bu yönden bakıldığında mevcut çalışma için en uygun yöntemin durum çalışması olduğu ortaya çıkmaktadır, zira odaklanılan beceri ile eğitsel bağlamların etkileşiminin ne olduğu ve nasıl oluştuğu hakkında betimsel bir araştırma gerçekleştirme hedefi ile yola çıkılmıştır. Üçüncü olarak, gerçekleştirilen çalışmanın bir boyutu da, belirli koşullar altında, küçük bir katılımcı grubunun (örn. sınıflar) doğal ortamında gerçekleşen durumlara açıklama getirmeyi gerektirmektedir, bu yönüyle durum çalışması bu çalışmanın hedefleri ile birebir örtüşmektedir. Son olarak, çoklu durum çalışması yaklaşımında, bir olguya farklı açılardan yaklaşılması imkânı vardır. Çoklu durum çalışmaları, katılımcıların farklı bir ortamda veya belirli görevler için koşullar değiştiğinde farklı davranıp davranmadıklarını gözlemlemek için durumların bağımsız değerlendirilmesine imkân vermesinin yanı sıra, tüm durumların çapraz değerlendirilmesini mümkün kılar (Bloomberg & Volpe, 2012; Stake, 2006). Bu şekilde çoklu durum çalışmalarında, tek veri kaynağına dayanan spesifik değişkenler üzerinde gerçekleştirilen çalışmalar ortaya koymaktan ziyade, çok sayıda kanıta dayanmak suretiyle ele alınan olgunun bütünsel ve bağlamsal anlamda kavranması yönünde geniş bir bakış açısı sağlar (Yin, 2009). Bu yönden bakıldığında, çoklu durum çalışması sonuçlarının genellikle tek duruma odaklanan çalışmalarda elde edilen sonuçlarla kıyaslandığında daha nitelikli ve sağlam sonuçlar sağladıkları kabul edilmektedir (West & Oldfather, 1995; Yin, 1994). Tüm bunlara dayanarak, bu çalışmanın araştırmacısı, çoklu durum çalışması kullanımının sonucunda, çocukların sistemsel düşünme becerileri sergileme yönündeki farklılıklarının daha iyi yakalanabileceğinden ve araştırma bulgularının genellenebilirliğini geliştirebileceğinden dolayı (Yin, 2009) çoklu durum çalışması deseni ile çalışmaya karar vermiştir.

2.2 Veri Toplama Süreci, Veri Toplama Araçları ve Veri Analizi

Bu araştırmada yer alan analiz birimini ve durumları seçmek üzere amaçlı ve uygun örneklem yöntemleri kullanılmıştır. Amaçlı örneklem yaklaşımda izlenen birkaç yol vardır. İlki araştırmanın birimi ile ilgilidir. Araştırmanın analiz birimi, araştırma kapsamında seçilen anaokullarda yer alan en büyük yaş çocuklardan oluşan öğrenme gruplarıdır. Daha önce de açıklandığı üzere sistemsel düşünme becerilerinin üst düzey düşünme becerileri olarak sınıflandırılması dolayısıyla okul öncesi ortamlardaki en büyük yaş grupları ile çalışılmaya karar verilmiştir. Bu öğrenme gruplarının içinde bulundukları anaokulları ve ülkelerin eğitim sistemleri bahse konu analiz birimlerinin bağlamları olarak sınırlandırılmıştır. Buna ek olarak yükseköğrenim görmüş ailelerin çocukları ile çalışılması kararı alınmıştır. Bu sebep daha önce de aktarıldığı üzere eğitim düzeyi yüksek ebeveynlerin çocuklarına daha zengin bilişsel uyaran sağlamalarına dayandırılmıştır. Son olarak, prototipik değer sağlaması bakımından yükseköğrenim görmüş ebeveynlerin çocuklarının devam ettiği anaakım anaokullarındaki öğrenme grupları ve anaakıma zıt bir bakış açısı ile oluşturulmuş, anaakım eğitim kurgularına eleştirel bir bakışla eğitim hizmeti sunan yükseköğrenim görmüş ebeveynlerin çocuklarının devam ettiği alternatif anaokullarındaki öğrenme grupları ile çalışılmıştır. Sonuç olarak, mevcut araştırmada yapılan amaçlı örneklemenin hedefi, farklı pedagojik yaklaşımların küçük çocukların sistemsel düşünme becerileri üzerindeki etkisini karşılaştırarak bütüncül bir bulguya erişmektir. Uygun örneklem yaklaşımı kapsamında araştırmacı coğrafi olarak erişiminin mümkün olduğu anaokulları ile işbirliğine gitmiştir. Pedagojik yaklaşımlarına göre sınıflandırılan iki temel tür durum aşağıda tanımlanmıştır:

Anaakım Okul Öncesi Eğitim Grubu (Durum): Bu terim, Türkiye'de merkezi olarak tasarlanan Milli Eğitim Bakanlığı Erken Çocukluk Eğitimi Programı'nı (MoNE, 2013) yakından takip eden okul öncesi grupları ve Almanya'da Berlin Federal Eğitim Bakanlığı tarafından eyalet özelinde tasarlanan *Berliner Bildungsprogram*'ı yakından takip eden okul öncesi grupları için kullanılmıştır.

Alternatif Okul Öncesi Eğitim Grubu (Durum): Bu terim, Türkiye'de Milli Eğitim Bakanlığı Okul Öncesi Eğitim Programı'nı izleyen okul öncesi gruplara ve Almanya'da *Berliner Bildungsprogram*ı alternatif ve eleştirel yollarla takip eden okul öncesi eğitim grupları için kullanılmıştır. Sunulan eğitim hizmetinde Sürdürülebilir Kalkınma için Eğitim atıfının bulunduğu anaokullarındaki öğrenme grupları ile çalışılmıştır.

Bu bağlamda her ülkeden bir anaakım bir de alternatif olmak üzere iki durumla çalışılması kararlaştırılmıştır. Almanya'dan araştırmaya dâhil edilen anaakım eğitim durumunda elde edilen nitelikli ve zengin veriler sonucunda bu durumun içinde bulunduğu anaokulda yer alan diğer büyük yaş grubunun araştırmaya yeni bir durum olarak eklenmesi kararı alınmıştır. Bu durumda yer alan çocukların ebeveyn eğitim düzeylerinin diğer durumlardaki çocukların ebeveyn eğitim düzeylerinden düşük olduğu kaydedilmiş, durum adlandırması bu tespit üzerinden yapılmıştır. Tablo 1'de örneklem stratejisi hakkında detaylar yer almaktadır.

Tablo 1. Örneklem stratejisi

Türkiye'deki Alternatif Eğitim Anaokulu (Bağlam) Anasınıfı: ***A-TR Durumu***	**Almanya'daki Alternatif Eğitim Anaokulu (Bağlam)** Anasınıfı: ***A-GR Durumu***	
Türkiye'deki Anaakım Eğitim Anaokulu (Bağlam) Anasınıfı: ***M-TR Durumu***	**Almanya'daki Anaakım Eğitim Anaokulu (Bağlam)** Anasınıfı (yükseköğrenim görmüş ebeveynlerin çocukları): ***M-GR-M Durumu***	**Almanya'daki Anaakım Eğitim Anaokulu (Bağlam)** Anasınıfı (lise ve altı düzeyde eğitim görmüş ebeveynlerin çocukları): ***M-GR-L Durumu***

Analiz birimi: Anaokulundaki en büyük yaş grubundaki çocuklar (*Vorschulegruppe, Anasınıfı öğrencileri*)

Bu doktora tez araştırma projesinde bulgulara, Tablo 2'de görüldüğü üzere araştırma sorularına göre kategorize edilmiş 10 veri kaynağını vasıtasıyla ulaşılmıştır. Tabloda yer alan tüm veri toplama araçları uzman paneli ve pilot aşamalarından geçmiştir.

Tablo 2. Veri toplama ve analiz stratejisi

Araştırma Soruları	**Katılımcılar**	**Analiz yöntemi**	**Veri Toplama Araçları**
1. Türkiye'deki ve Almanya'daki 4-6 yaşlarındaki okul öncesi çocukların sistemsel düşünme becerilerinin düzeyi nedir?	Çocuklar	Sürekli karşılaştırma metodu	• Graeme Base tarafından yazılan ve resimlenen "The Water Hole-Su Deliği" isimli çocuk hikâyesi • Yukarıda belirtilen hikâye baz alınarak hazırlanan Çocuk Görüşme Protokolü • Okul Öncesi Sistemsel Düşünme Gelişimsel Rubriği
1.1 Türkiye'deki ve Almanya'daki 4-6 yaşlarındaki okul öncesi çocuklarının sistemsel düşünme becerilerinin düzeyi çocukların yaşına, cinsiyetine, dil geçmişlerine ve ebeveyn eğitimi düzeylerine göre nasıl değişiklik göstermektedir?	Çocuklar	Betimsel istatistik	• Puan dağılım tabloları

Tablo 2-devam. Veri toplama ve analiz stratejisi

2. Türkiye'deki ve Almanya'daki var olan eğitim bağlamları ile çocukların sistemsel düşünme becerilerinin farklı yönleri arasındaki etkileşim kalıpları nelerdir? 2.1 4-6 yaş grubundaki okul öncesi çocukların sistemsel düşünme becerileri seviyeleri ile Türkiye'deki ve Almanya'daki eğitsel bağlamlar arasındaki etkileşim kalıplarını tanımlayan değişkenler nelerdir?	- Öğretmenler - Anaokulu Yöneticileri - Çocuklar	İçerik analizi	"Araç Temelli Sürdürülebilirlik ve Sistemsel Düşünme Göstergeleri Listesi" ve "Sürdürülebilirlik ve Sistemsel Düşünme Göstergeleri Kontrol Listesi" aşağıda sunulan veri toplama araçlarına dayandırılarak oluşturulmuştur: Öğrenme Deneyimi Gözlem Protokolü Öğrenme Ortamı Gözlem Protokolü Öğretmen Görüşme Protokolü Anaokulu Yöneticisi Görüşme Protokolü Saha Notları ve Araştırmacı Günceleri Ek Belgeler
3.1. Türkiye'den ve Almanya'dan seçilen anaakım ve alternatif durumlardaki 4-6 yaşlarındaki okul öncesi çocukların sistemsel düşünme becerilerinin düzeyi nedir? 3.2. Türkiye'den ve Almanya'dan seçilen anaakım ve alternatif durumların eğitsel bağlamlarının özellikleri nelerdir? 3.3. Aşağıdakiler arasındaki benzerlikler ve farklılıklar nelerdir?: 3.3.1. Türkiye'den seçilen anaakım ve alternatif eğitim durumlarına karşı Almanya'dan seçilen anaakım ve alternatif eğitim durumları 3.3.2 Türkiye'den seçilen anaakım eğitim durumuna karşı Almanya'dan seçilen anaakım eğitim durumları 3.3.3 Türkiye'den seçilen alternatif eğitim durumuna karşı Almanya'dan seçilen alternatif eğitim durumu	- Öğretmenler - Anaokulu Yöneticileri - Çocuklar	Durum İçi ve Durumlar Arası Çapraz Durum Analizi	Tüm enstrümanların kullanımı ile çapraz-durum analizi yapılacaktır.

2.2.1 Çocuk Öyküsü, Çocuk Görüşme Protokolü ve Okul Öncesi Sistemsel Düşünme Gelişimsel Rubriği

Çocuk görüşme protokolü, Graeme Base (2001) tarafından yazılan ve resimlenen "The Water Hole-Su Deliği" adlı kurgu çocuk öyküsüne paralel olarak uygulanmıştır. Hikâye okunurken ve okuma bittikten sonra katılımcı çocukların sistemsel düşünme becerilerinin doğasını keşfetmek üzere sistemsel düşünme becerilerinin özellikleri ile doğrudan ilgili 19 soru sorulmuştur. Öykü metni çocuk görüşme protokolü ile birlikte Appendix A'da sunulmuştur. Çocuk görüşme protokolü, çoğunlukla Sweeney'in (2001) kitabı, Ben-Zvi-Assaraf ve Orion'un (2005a, 2005b, 2010a, 2010b) çalışmaları ve Waters Foundation'ın erken çocukluk ortamlarındaki uygulamaları (Benson, LaVigne & Marlin, 2015) temel alınarak oluşturulmuştur. Bu çalışmalarda yer alan görüşme sorularına ilaveten bu çalışmanın araştırmacısı tarafından da yeni sorular oluşturulmuştur. Bu çalışmanın araştırmacısı ayrıca, araştırmada yer alan çocukların sistemsel düşünme becerilerini ölçmek amacıyla sistemsel düşünmenin sekiz bileşenini baz alarak Okul Öncesi Sistemsel Düşünme Gelişimsel Rubriği'ni oluşturmuştur (Appendix B).

Çalışmaya katılması hedeflenen çocukların ailelerine anaokullarının yönetimleri aracığıyla aile izin formu (Appendix J) gönderilmiştir. Ebeveynlerinden izin alınan çocuklardan ayrıca görüşme çalışması öncesinde sözlü izin alınmıştır. Görüşmeler her çocuk katılımcı ile bireysel olarak, görüşme için hazırlanmış sessiz bir odada yaklaşık 15 dakikalık bir sürede gerçekleştirilmiştir. Tüm görüşmelerin ses kaydı alınmıştır.

2.2.2 Sürdürülebilirlik ve Sistemsel Düşünme Göstergeleri Kontrol Listesi

Araştırmadaki durumların eğitsel bağlamlarını karşılaştırmalı, nesnel ve bütünsel bir bakış açısıyla ortaya koymak amacıyla, gözlem protokollerindeki ve yetişkin görüşme protokollerindeki maddeler bir kontrol listesine dönüştürülmüştür. Bu kontrol listesindeki bazı maddeler, Transfer-21 Programı (Transfer 21 Programme, 2007) kapsamında hazırlanan "SKE Okullarında Kalite Geliştirme: Kalite Alanları, İlkeleri ve Kriterleri" dokümanından alınmıştır ve okulların hem iç hem de dış değerlendirmesine yönelik bir çerçeve olarak kullanıma uygun şekilde bu araştırmaya uyarlanmıştır. Bazı maddeler, Hohmann, Weikart ve Epstein (2008) tarafından okul öncesi eğitim programları kapsamında gerçekleştirdikleri aktif öğrenme uygulamaları konusunda yapılan çalışmalardan alınmıştır. Kontrol listesindeki bir madde Massey'nin (2007) okul öncesi sınıflarındaki öğretmen-çocuk sohbeti üzerine yaptığı çalışmasında kullandığı Marion Blank'in Sorgulama Modeli Seviyeleri'ne dayandırılmıştır. Diğer maddeler bu çalışmanın araştırmacısı tarafından oluşturulmuştur. Bahse konu kontrol listesinde, farklı veri toplama araçları aracılığıyla toplanan farklı kanıtları 6 kalite alanı altında birleştirilmiştir. Kontrol listesinde yer alan göstergelerin bir kısmı yetişkin görüşme protokollerine, bir kısmı da gözlem protokollerine entegre edilmiştir. Diğer maddeler, her bir durumun seçilen kriterleri karşılayıp karşılamadığını anlamak için toplanan verilerin bütüncül bir değerlendirmesini gerektirmiştir. Verilerin toplanması sırasında kullanılan kontrol listesi, araçlar ve bu araçların maddeleri, Araç Temelli Sürdürülebilirlik ve Sistemsel Düşünme Göstergeleri Kontrol Listesi'nde (Appendix C) birleştirilmiştir. Bu veri toplama aracı ayrıca bir kontrol listesine dönüştürülmüştür (Appendix D) ve göstergelerin ne ölçüde karşılandığına dair üç kategori belirlenmiştir: (1) karşılanmamıştır (2) kısmen karşılanmıştır (3) tamamen karşılanmıştır.

Kontrol listeleri her bir durum için ayrı ayrı tamamlanmıştır. Bu süreçte izlenen yöntem şudur: (1) araştırmacı ve partnerleri farklı veri toplama araçları aracılığıyla toplanan kanıtları dikkate aldıktan sonra kontrol listelerini bireysel doldurmuştur, (2) listeler karşılaştırmaya tabi tutulup ortak ve ayrışmış yönler tespit edilmiştir, (3) farklı bir şekilde ele alınan maddeler tartışılmış ve öne sürülen argümanlar sonucunda anlaşmaya varılmıştır. Bu süreç, her bir durum için son bir kontrol listesi oluşturularak sonuçlandırılmıştır. Bu süreç tamamlandıktan sonra durumların betimlemeleri oluşturulmuştur.

2.2.3 Öğretmen ve Okul Yöneticisi Görüşme Protokolleri

Araştırmacı, öğretmen ve anaokulu yöneticisi görüşme protokolleri vasıtasıyla seçilen durumların bağlamsal detaylarını ortaya koyacak kanıtlar toplamayı hedeflemiştir. Görüşmeler yetişkin katılımcılarla sakin bir ortamda yaklaşık 20 dakikalık bir sürede gerçekleştirilmiştir. Görüşmeye başlamadan önce katılımcılar Gönüllü Katılım Formu’nu (Appendix I) okuyup imzalamıştır. Görüşmelerin daha sonra transkripsiyonlarını yapmak üzere ses kaydı alınmıştır. Öğretmen ve anaokulu yöneticisi görüşme formları (Appendix E ve Appendix F) dört bölümden oluşmaktadır.

-Bağlamı Tanıma

-Sürdürülebilirliğe Odaklanma

-Hizmet Öncesi ve Hizmet İçi Öğretmen Eğitimi

-Öğretmeni Tanıma

2.2.4 Katılımcı Gözlemleri ve Gözlem Protokolleri

Bu çalışmada yer alan durumların nispeten inkâr edilemez betimlemelerini (Stake, 1995) oluşturmak üzere katılımcı gözlemleri gerçekleştirilmiştir. Ayrıca bu gözlemler, okuyucu için temsili deneyimler (Stake, 1995) geliştirmek için bilgi toplamaya fırsat vermiştir. Bu çoklu veri kaynağının kullanımı, öğrenme gruplarının bağlamlarının tanımının zenginliğine ek yaparak, görüşmelerde toplanan verilerin derinleştirilmesi ve üçgenlenmesi için uygun bir zemin sağlamıştır. Denzin (1970) katılımcı gözlemini belge analizini, görüşmeyi, doğrudan katılımı ve gözlemi aynı zamanda birleştiren bir alan stratejisi olarak tanımlamıştır. Bu çalışmanın araştırmacısı sınırlı katılımcı gözlemci rolünü üstlenmeyi tercih etmiştir. Bu rolü üstlenirken, araştırmacı ve partnerleri okul öncesi grupların normal görevlerini ve etkileşimlerini mümkün olduğunca az bir şekilde kesintiye uğratmaya çalışmakla beraber gerekli zamanlarda katılımcılarla etkileşime girerek gözlemi yapılan faaliyetlerin açıklamasını ve anlamını sorma özgürlüğünü kullanmıştır.

Lincoln ve Guba'nın (1985) önerdiği gibi uzun süreli gözlem imkânı yakalamak üzere her bir durum 5 ardışık gün boyunca ziyaret edilmiştir, her durumda toplam 20 saatlik gözlem yapılmıştır. Gözlemler ekseriyetle eğitsel faaliyetlerin yoğun gerçekleştiği sabah saatlerinde gerçekleştirilmiştir. Gözlemler, analiz birimi olarak seçilen okul öncesi gruplarının vakitlerini geçirdikleri sınıflarda, yemek odasında, oyun alanlarında, parklarda, bahçelerde ve alan gezisi yapılan ortamlarda gerçekleştirilmiştir.

Çalışmada sistematik ve nesnel sonuçlara ulaşmak üzere çalışmanın araştırmacısı tarafından iki gözlem protokolü oluşturulup uygulanmıştır: Öğrenme Deneyimi Gözlem Protokolü (Appendix G) ve Öğrenme Ortamı Gözlem Protokolü (H). Bu veri toplama araçları kullanılarak eğitsel bağlamların kanıt temelli betimlemelerinin yapılması, öğrenme deneyimlerinin ve öğrenme ortamlarının sistemsel düşünme unsurlarını ve SKE yaklaşımını ne ölçüde kapsadıklarının kavramsallaştırılması amaçlanmıştır.

Araştırmacı ve partnerleri, gözlem yoluyla veri topladıkları dönemlerde gözlem formundaki maddeleri göz önünde bulundurarak gözlem yapmaya başladıkları andan itibaren saha notları tutmuştur. Her gözlem gününün sonunda tüm saha notları birlikte incelenmiş, karşılıklı anlaşmaya varıldıktan sonra, o günün öğrenme deneyimlerini betimlemek ve kavramsallaştırmak adına her gün için bir adet Öğrenme Deneyimi Gözlem Protokolü ortak mutabakata varılarak doldurulmuştur. Bir durum için tüm gözlem süreçleri gerçekleştirildikten sonra, tamamlanmış formlar yeniden incelenmiştir ve her bir durum için veri analizinde kullanılmak üzere o durumdaki öğrenme deneyimlerinin niteliğini ortaya koymak üzere son bir form doldurulmuştur, veri analizine bu form sokulmuştur.

Araştırmacı ve partnerleri, Öğrenme Ortamı Gözlem Protokolünü gerçekleştirdikleri gözlemler sonucunda bireysel doldurmuştur. Doldurulan gözlem protokolleri ilk gözlem gününün sonunda araştırmacı ve partnerleri tarafından ortaklaşa incelenmiş, karşılıklı mutabakata varıldıktan sonra her durum için mutabakatı yansıtacak şekilde yeni öğrenme ortamı gözlem protokolü hazırlanmıştır. Gerekli görülen durumlarda yine gözlemcilerin karşılıklı mutabakatı ile gözlem protokolüne gözlem sürecinde fark edilen hususları da dâhil etmek üzere bazı eklemeler yapılmıştır.

2.2.5 Saha Notları

Yukarıda açıklanan araçlara ek olarak, gözlemlenen tüm faaliyetlerin ve katılımcılar arasında gerçekleştirilen konuşmaların ayrıntılı alan notları, her günün sonunda incelenmek üzere ele alınmıştır. Veriler toplanırken araştırmacı, nitel soruşturmanın ortaya çıkışına bağlı olarak araştırma ilerledikçe yeni hususlara da odaklanmıştır. Bu edinilen bilgiler ayrıca saha notlarına eklenmiştir.

2.2.6 Ek belgeler

Yorumlama güvenini arttırmak ve çalışmanın derinliğini desteklemek amacıyla, Sürdürülebilirlik ve Sistemsel Düşünme Göstergeleri Kontrol Listesi'nde yer alan kalite göstergelerini n karşılanma düzeylerini ortaya koymak amacıyla araştırmaya dâhil edilen anaokullarının web siteleri, okullarda kullanılan ders planları gibi ek veri kaynakları da incelenmiştir. Bu çabanın ardında araştırmacının eğitsel bağlamlar hakkında daha derin bir anlayış kazanma çabası yatmaktadır (Bodgan & Biklen, 2006). Bu belgeler, üzerinde çalışılan anaokullarının pedagojik yaklaşımlarını okuyucuya ayrıntılı yansıtmak üzere içerik analizine tabi tutulmuştur. Buna ek olarak, veriler arasında da güvenirlik sağlamak adına gözlemleri ve görüşmeleri destekleyecek veya bunlarla ihtilafa düşecek nitelikte belgeler toplanmıştır (Glesne & Peshkin 1992).

3. Bulgular ve Öneriler

3.1 Erken Çocukluk Dönemindeki 4-6 Yaş Grubundaki Çocukların Sistemsel Düşünme Becerilerinin Kavramsallaştırılması

Bu araştırmada "Su Deliği" isimli hikâye vasıtasıyla gerçekleştirilen görüşmeler sonucunda 4-6 yaş aralığındaki çocukların sistemsel düşünme becerileri sekiz farklı unsur çerçevesinde kavramsallaştırılmıştır:

1. Dinamik Düşünme
2. Tek Yönlü Nedensellik
3. Geri Beslemeli Nedensellik
4. Büyük Resmi Görme
5. Sistem Mekanizmalarını Anlama
6. Problem Çözme
7. Görünmez Boyut
8. Zaman Boyutu-Geleceği Tahmin Etme

Araştırma bulguları ışığında 4-6 yaş aralığındaki çocukların sistemsel düşünme bağlamında ele alınan kademeli değişimler, iki basamaklı domino ve/veya çoklu tek yönlü nedensellik ve negatif geri beslemeyi tespit etme bağlamlarında nispeten karmaşık bir anlayış sergiledikleri sonucuna ulaşılmıştır. Buna ek olarak çocukların pozitif geri besleme, görünmez bileşenleri ve süreçleri tespit etme, sistemlerde gerçekleşen kasıtsız neticeleri kabul edecek şekilde sistem mekanizmalarını anlama, çok-boyutlu perspektif sergileme, yüksek tesirli müdahalelerle problem çözme ve sistemin gelecekteki davranışlarını tahmin etme bağlamlarında kapasitelerinin kısıtlı olduğu sonucuna varılmıştır.

3.1.1 Dinamik Düşünme

Araştırmaya katılan çocukların önemli bir kısmı hikâyede yer alan sistemlerdeki değişiklikleri, genel olarak ileri-geri veya varlık-yokluk düzeyinde ortaya koymuştur. Çocukların çoğu, kendilerine kademeli bir zaman perspektifi sunulduğunda sistemdeki kademeli değişimi fark ederek sistemdeki dinamizm hakkında fikir yürütmüştür. Çocukların sistemdeki açık bileşenler ve süreçlerle görünmez bileşenler ve süreçler arasındaki döngüsel dinamik davranış kalıbını tespit etme becerileri sınırlı düzeyde kalmıştır.

3.1.2 Geri Beslemeli Nedensellik

Çocukların tamamına yakını, su ile hayvanlar arasındaki gözle görünen ilişkiyi tespit ederek bu iki bileşen arasındaki kapalı döngüsel hareketi tanımlayabilmiştir. Çocukların sadece yarısı döngüsel hareketin oluşturduğu nedensel ilişkileri izlemeye devam ederek bileşenler arasındaki ilişkinin etki düzeylerini negatif geri besleme kavramı kapsamında tarif edebilmiştir. Çocukların sistemdeki pozitif geri besleme hareketini tespit etme becerileri sınırlı bulunmuştur.

3.1.3 Büyük Resmi Görme

Mevcut araştırmadaki çocukların, belirli bir konuyu bütünsel bir perspektifle anlamaya dair sınırlı bir beceri sergiledikleri sonucuna ulaşılmıştır. Çocukların meselelere tek boyutlu ve kısmi çok boyutlu bir perspektiften yaklaşmayı tercih ettikleri tespiti yapılmıştır. Çocukların bir bütünü oluşturmak üzere parçaların nasıl bir araya geldiklerini anlamlandırmaktan ziyade parçaların kendilerine odaklandıkları görülmüştür.

3.1.4 Sistem Mekanizmalarını Anlama

Ele alınan yaş grubundaki çocukların sistem mekanizmalarını anlama becerileri kısıtlı bulunmuştur. Araştırmaya katılan çocuklar, sisteme yeni bir bileşen eklendiğinde sistemde beklenmedik değişikliklerin gerçekleşebileceği ihtimalini göz önünde bulundurmamıştır. Çocukların yarısından azı, sisteme yeni bir bileşen eklenmesinin geniş ve uzun vadeli potansiyel etkilerini tanımlayabilmiştir. Yine, çocukların yarısından daha azı, sisteme yeni bir bileşen eklenmesinin dar ve kısa vadeli potansiyel etkilerini tanımlayabilmiştir. Araştırmaya katılan çocuklar arasında sisteme yeni bir bileşen eklenmesi durumunda sistemde bir değişiklik olmayacağını öngören çocukların da olduğu tespiti yapılmıştır.

3.1.5 Problem Çözme

Sistem düşüncesi penceresinden bakıldığında, araştırmaya katılan çocukların problem çözme becerilerinin kısıtlı olduğu sonucuna varılmıştır. Çocukların önemli bir kısmı ortaya konan problemi ya çözümsüz bırakmıştır ya da kısa vadeli semptomik çözüm önerileri ile ele almıştır. Bu yönde cevaplar sunan çocukların ürettikleri çözümlerin yeni sorunlar yaratabileceğine dair algılarının zayıf olduğu sonucuna varılmıştır. Çocuklardan sadece birkaçı, olası kök nedenlerine odaklanarak veya zaman içinde hareket etmek (sistemdeki gecikmeden haberdar olmak) veya kaynağı adil bir şekilde dağıtmak gibi daha karmaşık müdahale noktaları sunarak daha uzun vadeli bir tanı yaklaşımı sergilemiştir.

3.1.6 Görünmez Boyut

Sistemdeki görünmez bileşenlerin ve süreçlerin tespit edilmesi açısından çocuklarının becerilerinin sınırlı kaldığı tespiti yapılmıştır. Çocukların çoğunlukla sistemde yer alan gözle görülen bileşenlerin ve süreçlerin üzerinde durdukları kanısı oluşmuştur.

3.1.7 Zaman Boyutu-Geleceği Tahmin Etme

Sistemin zaman içinde nasıl işlediğinin çocuklar tarafından ne şekilde kavramsallaştırıldığı tespit edilmiştir, bu bağlamda çocukların geleceğe yönelik tahminlerinin geçmişte gerçekleşen mevcut kalıplar üzerinden oluştuğu tespiti yapılmıştır. Çocukların sisteme geniş bir zaman perspektifinden yaklaşma becerilerinin sınırlı olduğu sonucuna varılmıştır. Bu durumun çocukların ele alınan basit bir sistemin dahi karmaşık, dinamik, sürekli değişen bir özellikte olduğunu kavrayamamaları ile ilgili olduğu düşünülmektedir.

3.1.8 Tek Yönlü Nedensellik

Araştırmaya katılan çocuklar, bir neden-bir etki, çoklu nedenler ve/veya çoklu etkiler arasında tek yönlü ilişkiler kurma ve doğrudan ve dolaylı etkilerle sonuçlanan iki aşamalı doğrusal bağlantılar kurma konularında nispeten daha iyi bir anlayış sergilemiştir. Bununla birlikte, çocukların dolaylı etkileri olan üç veya daha fazla adımın yer aldığı doğrusal neden-sonuç ilişkileri kurmakta zorlandıkları sonucuna varılmıştır.

3.2 Çocukların Sistemsel Düşünme Skorlarının Farklı Değişkenlere Göre Dağılımı

Çalışmanın bu bölümünde, aşağıdaki araştırma sorusu çerçevesinde elde edilen bulgular sunulmuştur: Türkiye'deki ve Almanya'daki 4-6 yaşlarındaki okul öncesi çocuklarının sistemsel düşünme becerilerinin düzeyi çocukların yaşına, cinsiyetine, dil geçmişlerine ve ebeveyn eğitimi düzeylerine göre nasıl değişiklik göstermektedir?

Mevcut çalışmada, çocukların ulaştığı en yüksek puan 24 üzerinden 19, en düşük puan ise 2'dir. Yapılan analizler sonucunda katılımcıların yaş ortalamalarının artmasıyla skor ortalamalarının da arttığı sonucuna varılmıştır. Altı yaşındaki katılımcıların skor ortalamaları 14,12'dir, beş yaş grubunun (60-71 ay) skor ortalamaları 11,77'dir, dört yaş grubunun (48-59 ay) skor ortalaması ise 10,05'dir.

Çocuk katılımcıların skorları cinsiyet değişkenine göre analiz edildiğinde ise skorlarda farklılık gözlenmemektedir. Araştırmaya 27 kız ve 25 erkek çocuk katılmıştır. Kız çocukların yaş ortalamaları 61,40 aydır ve ortalama skorları 11,70 olarak hesaplanmıştır.

Erkek çocukların yaş ortalamaları 62,44 aydır ve ortalama skorları 11,40 olarak hesaplanmıştır.

Çocukların ebeveyn eğitim düzeyine göre skor dağılımlarına bakıldığında üniversite eğitimli ebeveynlerin çocuklarının puan ortalamasının 11,58 (bu grubun yaş ortalaması 60,5 aydır), ebeveynleri lise veya altı eğitimi olan çocukların puan ortalamasının ise 11,90 (bu grubun yaş ortalaması 67,09 aydır) olduğu görülmüştür.

Çocukların dil altyapılarına gelindiğinde 12 çocuğun çift dilli oldukları, yaş ortalamalarının 62,08 ay olduğu ve skor ortalamalarının 11,66 olduğu tespit edilmiştir. Çift dilli olmayan çocuk sayısı 40'tır, bu çocukların yaş ortalaması 61,85 aydır ve ortalama skorları 11,65'tir. Hatırlatmak gerekir ki, çift dilli olan çoğu çocuğun ebeveynleri daha düşük eğitim düzeyine sahiptir.

Sonuç olarak, skor dağılımları yaş, cinsiyet, ebeveyn eğitim düzeyi ve çocuğun dil arka planı değişkenlerine göre düzenlendiğinde yaş dışındaki diğer değişkenlerin ortalama skorlara dikkate değer bir etkilerinin olmadığı sonucuna varılmıştır. Yaş değişkeni ele alındığında, çocukların yaşı arttıkça, ortalama skorlarının da arttığını göstermektedir.

3.3 Okul Öncesi Eğitsel Bağlamların Okul Öncesi Çocukların Sistemsel Düşünme Becerileri Üzerindeki Etkisi

Çalışmanın bu bölümünde ikinci araştırma sorusu olan eğitsel bağlamların çocukların sistemsel düşünme becerilerine olan etkisi ele alınmıştır. Ele alınan bağlamın bütünsel bir betimlemesini yapmak üzere, Türkiye'deki ve Almanya'daki erken çocukluk eğitim sistemi makro düzeyde, araştırma için seçilen anaokulları meso düzeyde, araştırmada ele alınan durumlar ise mikro düzeyde Sürdürülebilirlik ve Sistemsel Düşünme Göstergeleri Kontrol Listesi çerçevesinde altı ana başlık altında betimlenmiştir:

1. Anaokulunun İklimi
2. Fiziksel Alan
3. Öğrenmeye ve Deneyimlere Yönelik Yaklaşımlar
4. Düşünme ve Davranma Rutinleri
5. Sürdürülebilirlik Odağı
6. Sistemsel Düşünme Açıları

Yukarıda bahsi geçen başlıklar çerçevesinde bu araştırma kapsamında oluşturulmuş 57 kriterin her durumda karşılanma düzeyi tespit edilerek durum betimlemeleri oluşturulmuştur. Oluşturulan betimlemeler ve durumlarda yer alan çocukların sistemsel düşünme becerileri ortak bir matriste karşılaştırmalı bir yaklaşımla ele alınmıştır (Tablo 48). Tüm bu karşılaştırmaların sonucunda okul öncesi çocukların sistemsel düşünme becerilerine etki etme potansiyeli olan değişkenler ortaya konmuştur. Bu bağlamda öncelikle çocukların doğuştan gelen özellikleri (doğuştan gelen bilişsel özellikler, yaş ve cinsiyet), çevresel etmenler (ebeveyn eğitim düzeyi ve çift dilli yetiştirilme) ele alınarak bulgular tartışılmıştır. Erken çocukluk dönemindeki çocukların sistemsel düşünme becerileri bu dönemdeki çocukların beyin komuta merkezlerinin özellikleri ile açıklanmıştır. Bu açıklamalardan yola çıkarak özellikle yaşın ilerlemesiyle çocukların sistemsel düşünme becerisi sergilemeleri yönündeki fonksiyonların arttığı tarif edilmiştir. Aynı yaşta olup da farklı sistemsel düşünce becerileri sergileyen çocuklarla ilgili bulgular doğuştan gelmesi muhtemel bilişsel özelliklerden kaynaklanan bireysel farklılıklardan doğabilmiş olabileceği argümanı tartışılmıştır. Buna ek olarak, küçük çocukların alıcı ve ifade edici dil becerileri üzerinde durulmuş, yine yaşa bağlı olarak özellikle ifade edici dilin nispeten geç bir dönemde geliştiğine dair bulgulara yer verilmiştir.

Sistemsel düşünme becerilerinin üst düzey bilişsel beceri kategorisinde olması sebebiyle çalışmaya katılan çocukların aile eğitim düzeylerinin çocukların ele alınan becerileri üzerindeki etkisi irdelenmiştir. Çalışmaya sonradan eklenen göçmen kökenli, lise veya daha düşük düzeyde eğitim seviyesine sahip ebeveynleri olan çocukların sistemsel düşünme becerileri ile yükseköğrenim görmüş ebeveynlerin çocukların sistemsel düşünme becerilerinin yakın olduğu tespiti yapılmıştır. Araştırmacı, tüm araştırma sürecinden edindiği bulgular ve tecrübe sonucunda bu bulguyu daha düşük düzeyde eğitime sahip ebeveynleri olan çocuklara sunulan erken çocukluk eğitiminin niteliği ile ilişkilendirmiştir. Bu bağlamda nitelikli eğitimin dezavantajlı çocuklara yönelik "eşitleyici" etkisi üzerinde durulmuştur.

Sürdürülebilirlik ve Sistemsel Düşünme Göstergeleri Kontrol Listesi'nde yer alan göstergelerden ve toplanan demografik bilgilerden yola çıkarak 4-6 yaş grubu okul öncesi çocukların sistemsel düşünme becerilerine etki etme potansiyeli olan eğitsel bağlam değişkenleri üzerinde çalışıldığında okul öncesi eğitim kurumuna devam etme süresinin (okul öncesi eğitim almaya başlama yaşı), çocukların çatışma çözme becerilerinin kolaylaştırılmasının, çocuklara sistemleri görme ve sistemlere dokunma gibi sistemlerle alakalı dıştan görülebilen deneyimler yaşatılmasının, çocukların öğrenme deneyimlerinin proje tabanlı öğrenme yaklaşımı ile derinleştirilmesi ve birbirleri ile ilişkilendirilmesinin, sürdürülebilirlik paradigmasında da yer aldığı şekilde eleştirel düşünme süreçlerinin işletilmesinin, çocuklara bilişsel olarak zorlayıcı soruların sorulmasının ve tüm bu eğitsel bağlam özelliklerini yürüten ve uyumlaştıran öğretmenlerin çocukların sistemsel düşünme becerilerine etki edebilecekleri değişkenler olabileceği sonucuna varılmıştır. Bu çalışma ayrıca araştırmada yer alan durumlardaki sistem düşüncesi eğitsel olanakları bağlamındaki yoksunluğun altını çizmiştir. Araştırmada yer alan durumlarda yer aldığı eğitsel bağlamlarda sistemler, kapalı döngüsel ilişkiler, köken sebepler, sebepler ve sonuçlar arasında etki düzeyleri, görünmez bileşenler ve süreçler, kasıtsız neticeler, devimsellik, karmaşıklık, yani kısaca sistemlerin nasıl çalıştığına dair çalışmalar yapılmadığı neticesine varılmıştır.

Çalışmada netice itibariyle 4-6 yaş okul öncesi çocuklarının sistemsel düşünme becerilerinin kısıtlı olduğu sonucuna varılmıştır. Buna etki etmesi muhtemel sebeplerden birisi daha önce de detayları aktarılan erken çocukluk dönemi kapsamında ele alınan bilişsel gelişimsel süreçlerdir. Diğer gerekçenin insanlığın geçirdiği gelişimsel süreçle açıklanması mümkün görünmektedir. Forrester'ın (1992) da ifade ettiği üzere insan aklı, resimleri, haritaları ve statik ilişkileri harika bir şekilde yakalar. Ancak, zamanla değişen etkileşimli bileşenlerin olduğu sistemlerde, insan aklı, davranışların zayıf bir simülatörüdür. Günümüz insanının algı yapısının sistemlerin sadece tek yönlü, basit, görünen ve statik özelliklerini ele alabildiğine dair açıklamalar yapılmaktadır. Bu zorluğu aşmak adına sistem dinamikleri disiplini bünyesinde farklı simülasyon modellerinin de kullanıldığı bilgisayar programları üretilmiştir. Bu programların çocuklar için üretilmiş versiyonları da bulunmaktadır. İnsan algısının kısıtlı kaldığı durumlarda bu tür bilgisayar programları işler hale getirilerek günümüz toplumlarının sorunlarına yenilikçi çözümler sunmak adına sistem düşüncesi yaklaşımından istifade edilmesi mümkün kılınabilinir.

4-6 yaş okul öncesi çocukların kısıtlı düzeyde sistem düşüncesi becerileri sergilemelerin ardında yatan muhtemel sebeplerden diğeri az önce açıklanan eğitsel bağlamlardaki sistem düşüncesi yaklaşımının yoksunluğudur. Bu bağlamda bu tez çalışmasında üç düzeyde eğitsel önerilerde buluşmuştur. En üst düzeydeki öneri günümüz toplumlarında işler halde bulunan eğitsel paradigma ile ilgilidir. Günümüz eğitim sistemlerinde yer alan parçalara ayırılmış, mekanik ve indirgeciyi paradigmanın daha bütünsel, etkileşimli ve çok katmanlı bir paradigma ile değiştirilmesi önerilmektedir. Bu bağlamda eğitim politika yapıcılarının sistem düşüncesi yaklaşımını benimsemeleri, bu yaklaşımı okul öncesi eğitim programlarının boylamsal boyutlarından biri olarak ele alarak eğitsel paradigmaya entegre etmeleri tavsiye edilmektedir. Bu entegrasyon kapsamında sistem düşüncesi yaklaşımının okul öncesi öğretmenlerine yönelik hazırlanan hizmet öncesi ve hizmetiçi eğitim içeriklerine dahil edilmesinin gerekliliği üzerinde de durulmuştur. Araştırmada sunulan uygulama düzeyindeki önerilerin muhatapları erken çocukluk eğitimi uygulayıcılarıdır. Daha önce de ifade edildiği üzere araştırmada yer alan durumlarda sistem düşüncesi yaklaşımına dair eğitsel olanaklara rastlanmamıştır. Üstelik araştırmaya katılan yetişkinler açıkça bu yaklaşımdan haberdar olmadıklarını ifade etmiştir. Bu bağlamda erken çocukluk eğitimcilerinin bu alanda donanım edinmeleri, çocukların sistem düşüncesi becerilerini geliştirmek üzere uygulamalar yapmaları önerilmektedir. Zaman-içinde-hareket grafikleri, döngüsel nedensellik modelleri, bağlantı çemberleri, kavram haritaları, simülasyon programları eğitsel ortamlarda kullanılabilecek sistem eğitsel araçlarından bazılarıdır.

Bu araştırmada bütünsel bir kurgu ile oluşturulmuş, zamana yayılmış, birbiriyle bağlantılı öğrenme deneyimleri içeren derin proje çalışmaları yapılan ortamlardaki çocukların daha nitelikli sistem düşüncesi becerileri ortaya koydukları tespiti yapılmıştır. Bu bakımdan bu araştırma proje tabanlı öğrenmenin sürdürülebilir bir gelecek inşa edebilecek olan sistem vatandaşları üzerindeki potansiyel etkisinin özellikle altını çizmektedir. Bu yaklaşım içinde ele alınabilecek stratejilerden bazıları şunlardır: çocukların aktif öğrenenler olduklarını kabul etmek, öğrenme deneyimleri kurgularken çocukların ilgilerini ve ihtiyaçlarını takip etmek, proje içeriklerini seçerken çocuğun dünyasından hareket etmek, çocuğun bilgi birikimini ve perspektifini çok disiplinli ve interdisipliner yaklaşımla derin araştırmalar yoluyla ilerletmek, çocuğun sosyal ve entelektüel özgürlüğünü desteklemek, işbirlikli öğrenmeyi mümkün kılmak, çocuklara kendi öğrenme deneyimlerini gözlemleyebilme imkânı sağlayabilecek dokümantasyon teknikleri geliştirmek.

Bu araştırmanın eğitimcilere sunduğu diğer öneri çocukların sistem vatandaşları olmaları yönünde desteklemek üzere eğitimin sürdürülebilirlik prensipleri temelinde düzenlenmesini sağlamaktır, zira sistem düşüncesi ve sürdürülebilirlik yaklaşımları bütünsel yaklaşım, ilişkiler ağı, karmaşıklık, dinamik ilişkiler, yüksek tesirli müdahaleler gibi farklı alanlarda ortak yönler içermektedir. İki yaklaşımda da konulara eleştirel ve yaratıcı yönlerden bakmanın önemi vurgulanmaktadır. Bu araştırma sistemler üzerinde çalışmanın, bilişsel olarak zorlayıcı sorular sormanın, çok kültürlülüğün ve çok dilliliğin küçük çocukların sistemsel düşünme becerilerinin geliştirilmesi yönünde anlamlı fırsatlar sağlama potansiyelinin altını çizmektedir.

Kaynakça

Ardila, A., Rosselli, M., Matute, E., & Guajardo, S. (2005). The influence of parents' educational level on the development of executive functions. *Developmental Neuropsychology*, *28*, 539–560.

Base, G. (2001). *The water hole.* New York: Harry N. Abrams, Inc.

Benson, T. A. (2007). *Developing a systems thinking capacity in learners of all ages.* Retrieved from http://www.watersfoundation.org/webed/library/articles/Developing-STcapacity.pdf

Benson, T., LaVigne, A., & Marlin, S. (2015). *Developing understanding of dynamic systems within early childhood settings.* Paper presented at the 33rd International Conference of the System Dynamics Society, Cambridge, Massachusetts.

Ben-Zvi-Assaraf, O., & Orion, N. (2005a). A study of junior high students' perceptions of the water cycle. *Journal of Geological Education*, *53*(4), 366-373.

Ben-Zvi-Assaraf, O., & Orion, N. (2005b). Development of system thinking skills in the context of earth system education. *Journal of Research in Science Teaching, 42*(5), 518-560.

Ben-Zvi-Assaraf, O., & Orion, N. (2010a). Four case studies, six years later: Developing system thinking skills in junior high school and sustaining them over time. *Journal of Research in Science Teaching, 47,* 1253–1280.

Ben-Zvi-Assaraf, O., & Orion, N. (2010b). System thinking skills at the elementary school level. *Journal of Research in Science Teaching, 47,* 540-563.

Bloomberg, L. D., & Volpe, M. (2012). *Completing your qualitative dissertation: A road map from beginning to end* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Boardman, J., & Sauser, B. (2008). *Systems thinking: Coping with 21st century problems.* Taylor and Francis/CRC Press.

Bosh, O. J. H., King, C. A., Herbohn, J. L., Russel, I. W., & Smith, C. S. (2007). Getting the big picture in natural resource management—systems thinking as 'method' for scientists, policy makers, and other stakeholders. *Systems Research and Behavioral Science*, *24*, 217–232.

Center for Ecoliteracy (n.d.). *Systems thinking.* Retrieved May 17, 2017, from http://www.ecoliteracy.org/article/systems-thinking

Delauzun, F., & Mollona, E. (1999). Introducing system dynamics to BBC World Service: An insider perspective. *Journal of the Operational Research Society, 50*(4), 364-371.

Denzin, N. K. (1970). *The research act: A theoretical introduction to sociological methods.* New York: Aldine Publishing Company.

Doyle, J., Radzicki, M., & Trees, S. (1998). *Measuring changes in mental models of dynamic systems: An exploratory study.* Paper presented at the 16th International Conference of the System Dynamics Society, Quebec City, Canada.

Fazey, I. (2010). Resilience and higher order thinking. *Ecology and Society, 15*(3), 9.

Forrester, J. W. (1992). *System dynamics and learner-centered-learning in kindergarten through 12th grade education.* Road Map Series Paper (D-4434-1), Massachusetts Institute of Technology.

Forrester, J. W. (2007a). Systems dynamics – a personal view of the first fifty years. *System Dynamics Review, 23*(2-3), 345–358.

Forrester, J. W. (2007b). Systems dynamics – the next fifty years. *System Dynamics Review, 23*(2-3), 359–370.

Glesne, C., & Peshkin, A. (1992). *Becoming qualitative researchers: An introduction*. White Plains, New York: Longman.

Goerner, S. J. (2007). Today's Copernican flip: How putting collaborative learning at the hub of human evolution improves our chances of survival. *Systems Research and Behavioral Science, 24*(5), 481–491.

Hammond, D. (2003). *The science of synthesis: Exploring the social implications of general systems theory*. Boulder: University Press of Colorado.

Hoff, E. (2003a). Causes and consequences of SES-related differences in parent-to-child speech. In M. H. Bornstein, & R. H. Bradley (Eds.), *Socioecononomic status, parenting, and child development* (pp. 147–160). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Hoff, E. (2003b). The specificity of environmental influence: Socioeconomic status affects early development via maternal speech. *Child Development*, *74*, 1368–1378.

Hohmann, M., Weikart, D. P. & Epstein, A. S. (2008). *Educating young children: Active learning practices for preschool and child care programs (3rd ed.).* Ypsilanti, MI: High/Scope Press.

Jacobsen, M. J., & Wilensky, U. (2006). Complex systems in education: Scientific and educational importance andimplications for the learning sciences. *Journal of the Learning Sciences*, *15*(1), 11–34.

LaVigne, A. (2009). *Systems thinking and dynamic modeling within K-12 schools: effects on student learning*. Retrieved from http://www.ppi-int.com/newsletter/SyEN-012.php#article

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

Lyneis, D. A., & Fox-Melanson, D. (2001). *The challenge of infusing system dynamics into a K-8 curriculum*. Paper presented at the 19th International System Dynamics Society Conference, Atlanta, Georgia.

Maani, K. E., & Maharaj, V. (2004). Links between systems thinking and complex decision making. *System Dynamics Review, 20*, 21–48.

Mandinach, E. B., & Cline H. F. (1989). Applications of simulation and modeling in precollege instruction. *Machine-Mediated Learning*, *3*, 189-205.

Massey, S. L. (2004). Teacher–Child Conversation in the Preschool Classroom. *Early Childhood Education Journal, (31)*4, 227-231.

Meadows, D. H., & Wright, D. (2008). *Thinking in systems: A primer*. White River Junction, Vt.: Chelsea Green Pub.

Merriam, S. (1998). *Case study research in education: A qualitative approach.* San Francisco, CA: Jossey-Bass.

Meyfroidt, P. (2013). Environmental cognitions, land change, and social–ecological feedbacks: an overview. *Journal of Land Use Science, 8*(3), 341–367.

Ministry of National Education-MoNE (2013). *Okul Öncesi Eğitim Programı.* Ankara: MEB.

Moore, M-L., & Westley, F. (2011). Surmountable chasms: Networks and social innovation for resilient systems. *Ecology and Society, 16*(1), 5.

Pink, D. H. (2005). *A whole new mind why right-brainers will rule the future.* New York: Riverhead Books.

Plate, R. (2010). Assessing individuals' understanding of nonlinear causal structures in complex systems. *System Dynamics Review, 26*(1), 19–33.

Porter, T., & Córdoba, J. (2009). Three views of systems theories and their implications for sustainability education. *Journal of Management Education, 33*(3), 323-347.

Senge, P. M., Aleiner, A., Roberts, C., Ross, R., & Smith, B. (1994). *The fifth discipline fieldbook: Strategies and tools for building a learning organization.* New York: Doubleday.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization.* New York: Doubleday.

Skaza, H., & Stave, K. (2010). *Assessing the effect of systems simulations on systems understanding in undergraduate environmental science courses*. Paper presented at the 28th International Conference of the System Dynamics Society, Seoul, Korea.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.

Stake, R. E. (2006). *Multiple case study analysis.* New York: Guilford Press.

Sweeney, L. B. (2001). *When a butterfly sneezes: A guide for helping kids explore interconnections in our world through favorite stories.* Waltham, MA: Pegasus Communications.

Transfer 21 Programme (2007). *Developing quality at "ESD Schools" quality areas, principles and criteria.* Berlin: Freie Universität Berlin.

Waddock, S. (2006). *Leading corporate citizens: Vision, values, value-added* (2nd ed.). New York: McGraw Hill.

Wals, A. E. J. (2015). *Beyond unreasonable doubt - Education and learning for socio-ecological sustainability in the anthropocene*. *Inaugural address held upon accepting the personal Chair of Transformative Learning for Socio-Ecological Sustainability at Wageningen University*. Retrieved from http://edepot.wur.nl/365312

West, J., & Oldfather, P. (1995). Pooled case comparison: An innovation for cross-case study. *Qualitative Inquiry, 1*(4), 452–464.

Wu, H-K. (2010). Modelling a complex system: Using novice-expert analysis for developing an effective technology-enhanced learning environment. *International Journal of Science Education, 32*(2), 195–219.

Wulun, J. (2007). Understanding complexity, challenging traditional ways of thinking. *Systems Research and Behavioral Science, 24*, 393–402.

Yates, J., & Davidson, A. (n.d.). *Seeing below the surface: Systems thinking.* Retrieved from http://www.watersfoundation.org/webed/library/articles/STarticle-07.pdf

Yin, R. K. (1994). *Case study research: Design and methods.* Thousand Oaks, CA: Sage Publications.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage Publications.

Yoon, S. A. (2008). An evolutionary approach to harnessing complex systems thinking in the science and technology classroom. *International Journal of Science Education, 30*(1), 1–32.

M: TEZ FOTOKOPISI İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü	
Sosyal Bilimler Enstitüsü	X
Uygulamalı Matematik Enstitüsü	
Enformatik Enstitüsü	
Deniz Bilimleri Enstitüsü	

YAZARIN

Soyadı : Feriver Gezer
Adı : Şebnem
Bölümü : Temel Eğitim ve Okul Öncesi Eğitim Bölümü

TEZİN ADI (İngilizce) : Systems thinking skills of preschool children in early childhood contexts of Turkey and Germany

TEZİN TÜRÜ : Yüksek Lisans [ ] Doktora [X]

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. [ ]
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. [ ]
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. [X]

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: