CONNECTING SCIENCE COMMUNICATION TO SCIENCE EDUCATION: A PHENOMENOLOGICAL INQUIRY INTO MULTIMODAL SCIENCE INFORMATION SOURCES AMONG 4TH AND 5TH GRADERS

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ABSTRACT

CONNECTING SCIENCE COMMUNICATION TO SCIENCE EDUCATION: A PHENOMENOLOGICAL INQUIRY INTO MULTIMODAL SCIENCE INFORMATION SOURCES AMONG 4TH AND 5TH GRADERS

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Science communication, as a multidisciplinary field, serves to transfer scientific information to individuals to promote interest and awareness in science. This process resembles science education. Rooted in science education and science communication studies, this study examines the 4th and 5th grade students` usage of prominent science information sources (SIS), the features of these sources, and their effective and ineffective uses and processes in communicating science to students. Guided by situated learning and uses and gratifications (U&G) theories, this study is a phenomenological qualitative inquiry. Data were gathered through approximately 64 hours of classroom observations; focus group and individual interviews from four elementary schools (two public, two private schools) in Ankara, Türkiye. Focus group interviews were conducted with 47 students, and individual interviews were carried out with 17 teachers and 10 parents. The data were analyzed manually and MAXQDA software respectively.

The results revealed that students used various SIS in school-based and beyond contexts to satisfy their cognitive, affective, personal, and social integrative needs. They used SIS for (a) science courses, (b) homework/project assignments, (c) exam/test preparations, and (d) individual science related research. Moreover, the results indicated that comprehensible, enjoyable, entertaining, interesting, credible, brief, updated, and visual aspects of content and content presentation of SIS were among the key drivers affecting students` use of SIS. The results revealed that accessibility of SIS was an important variable in students` use of these sources. Results further shed light on the connection between science education and science communication in terms of promoting science learning.

Keywords: Science Education, Science Communication, Science Learning, Science Information Sources, Phenomenological Study.

ÖZ

BİLİM İLETİŞİMİNDEN FEN EĞİTİMİNE YANSIMALAR:
4. ve 5. SINIF ÖĞRENCİLERİNİN ÇOK BOYUTLU BİLİMSEL BİLGİ KAYNAKLARI ÜZERİNE BİR OLGUBİLİM ÇALIŞMASI

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Bilim iletişimi, çok disiplinli bir alan olarak, fen bilimlerine karşı ilgi ve farkındalığı arttırmak amacıyla bilimsel bilginin iletilmesine hizmet eder. Bu süreç, fen eğitimi ile benzerlik göstermektedir. Fen eğitimi ve bilim iletişimi çalışmalarına dayanan bu araştırma, 4. ve 5. sınıf öğrencilerinin bilimsel bilgi kaynaklarını kullanımlarını, bu kaynakların özelliklerini, kullanım şekillerini ve bu süreçleri, öğrencilerin fen öğreniminde etkili ve etkisiz kılan özelliklerini irdelemektedir. Yerleşmiş öğrenme, kullanım ve memnuniyet temelli kuramlardan yola çıkan bu çalışma, olgubilime dayalı bir nitel araştırmadır. Veriler, yaklaşık 61 ders saati sınıf-içi gözlem, grup ve bireysel görüşmeler aracılığıyla, Ankara ilinde 4 farklı okuldan (iki devlet, iki özel okul) toplanmıştır. Bu doğrultuda, 47 öğrenci ile odak grup görüşmeleri, 17 öğretmen, ve 10 veli ile bireysel görüşmeler yapılmıştır. Veri analizi, sırasıyla kağıt üzerinde kodlama ve MAXQDA programı aracılığıyla yürütülmüştür.

Araştırma sonuçları, öğrencilerin bilimsel bilgi kaynaklarını bilişsel, duyuşsal, kişisel ve sosyal bütünleştirici ihtiyaçlarını karşılamak üzere okul-içi ve okul dışı ortamlarda kullandıklarını ortaya koymaktadır. Öğrencilerin, bu kaynaklardan (a) fen derslerinde, (b) ödev ve projelerde, (c) sınav ve test hazırlıklarında, ve (d) bireysel fen araştırmalarında yararlandıkları görülmektedir.

Bunun yanı sıra öğrenciler, bilimsel bilgi kaynaklarında, sunulan bilginin içeriğinde ve sunum şeklinde anlaşılabilirlik, eğlenceli olma, ilgi çekicilik, güvenilirlik, açıklık, güncellik, görsellik gibi özellikler aramaktadır. Sonuçlar, kaynak ulaşılabilirliğinin de kaynak kullanımını etkileyen bir faktör olduğunu ortaya çıkarmıştır. Sonuçlar, ayrıca, fen öğrenimini güçlendirmek açısından, fen eğitimi ve bilim iletişimi arasındaki bağlantıya da ışık tutmaktadır.

Anahtar Kelimeler: Fen Eğitimi, Bilim İletişimi, Fen Öğrenimi, Bilimsel Bilgi Kaynakları, Olgubilim Çalışması.

To My Family...

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LIST OF ABBREVIATIONS

BoE	Board of Education
METU	Middle East Technical University
MoNE	Ministry of National Education
MTA	General Directorate of Mineral Research and Exploration
SIS	Science Information Sources
U&G	Uses and Gratifications

CHAPTER I

INTRODUCTION

> For the past twenty years at least, research coming from the area of science education has revealed a public that is fearful, mistrustful and ignorant of simple scientific principles. Why has education failed to address these problems and what should science communication know in order to be more effective?
>
> Stocklmayer, 2001

This study, which builds its conceptual framework on science education and science communication studies, focuses on the 4th and 5th grade students` uses of various sources in learning science and students`, parents`, and teachers` views on these sources` effectiveness in bringing science to students. This chapter presents the background to the study, purpose and significance of the study, and definitions of the core concepts used throughout the study.

1.1. Background to the Study

People learn science from a variety of sources in different learning environments (Falk, Donovan, & Woods, 2001). Although media serves as an important source of learning outside the school, we get to know about science in school environments (Brossard & Nisbet, 2007). Today, school is regarded as a place where most of the population contacts with a systematic formal instruction and explanation of science for the first time (Negrete & Lartigue, 2004). Obviously schooling is an important factor in students` learning of scientific knowledge (e.g., conceptions, theories, laws, models). Miller (2004) asserts that an individual's understanding of science may depend on his/her understanding of basic concepts or constructs. In line with this, education serves as a catalyst that affects conceptualizing various subjects later in life, as well (Neuman, 1981; Tichenor, Donohue, & Olien, 1970). In line with this, a meta-analysis of the results of nearly 200 surveys conducted in 40 countries revealed that the more people knew about science, the more likely they were to have positive attitudes toward science (Brossard & Nisbet, 2007). Educated people, whether measured in terms of general education or science education, are more likely to defer to the authority of science than those with lower education levels which could indicate that education is strongly related to deference to science (Brossard & Nisbet, 2007). According to Miller (2004), most people rely on their previous education for those basic concepts and understandings about science. Moreover, what and how is thought in childhood largely determines an individual`s view of the subject in adult life (House of Lords, 2000).

The effect of childhood science experiences on adult participation to science is among the main concerns of science education and communication scholars. This concern has manifested itself in a number of current studies as well (Bell, Lewenstein, Shouse, & Feder, 2009; Elsley & McMellon, 2010; Brossard & Nisbet, 2007; Osborne, Collins, & Simon, 2003; Oskala, Keaney, WingChan, & Bunting, 2009). In a study conducted by Elsley and McMellon (2010), it was found that participation beyond school science activities in childhood had a long term impact on adult participation in science. Parallel with this, they suggested noteworthy links between childhood and adult participation in cultural activities, including participation in science events at museums and science centers. Their research further established a correlation between the childhood experiences and adulthood interests. Accordingly, adult recollections of exposure to beyond school science in childhood indicated that these experiences did have a long term impact on adult participation. Even the importance of learning in beyond school settings were highlighted throughout the study and the idea of connecting school based and school beyond environments were also capitalized. Similar to Elsley and McMellon`s (2010) study, Oskala et al. (2009) explored the effects of childhood experiences on adult participation in art engagement and concluded that encouraging children today would help build audiences for tomorrow. In another study, Falk and Dierking (2010) asserted that not only adult free-choice learning experiences but also childhood free-choice learning experiences significantly contributed to adult science knowledge. In this contribution to adult science knowledge, school based science learnings in childhood seemed to remain school beyond science learnings.

As a global concern, students` attitudes towards science are on a gradual decline. There exist many studies related to decline in science attitudes, interests, and enthusiasm among school-age children. For illustration, a number of studies point out declines in attitude towards science over time (Catsambis, 1995; Hofstein & Welch, 1984; Weinburgh, 1998), attitudes towards science from age 11 onwards (Breakwell & Beardsell, 1992), attitudes towards science from elementary to high school level (Piburn & Baker, 1993), interest in science among school-age students (Gilbert, 2008), and enthusiasm for science even through the ages of 5-11 (Pell & Jarvis, 2001). Parallel with this, it seems that low interest has a negative influence on students` academic achievement in science and in their pursuit of science-related careers (Chapman, 1997; Sorge, Newsom, & Hagerty, 2000).

These results are in accordance with the data obtained in Baykul (1990) and Buluş-Kırıkkaya`s (2011) studies which could be regarded as two representative studies in Türkiye. According to Baykul (1990), students` attitude towards science and math was the highest in the 5th grade, and then it declines from grade 5 through grade 11. Likewise, Buluş-Kırıkkaya (2011) reported that science enthusiasm fell significantly from grade 4 to grade 8.

The media, as a well known science information source (SIS), has an important influence on attitudes toward science (Lee & Scheufele, 2006). Media's role in science education is threefold: In the first place, media sources made science more accessible for students (Osborne & Collins, 2000). Next, outside the school, media are the most available and sometimes the only source to gain information about scientific issues (Nelkin, 1995). Thirdly, people learn most of their science knowledge by means of media (Detjen, 1995). Considering these, media`s role in science education is increasing gradually (Dierking, 2005; Fenichel & Schweingruber, 2010).

Türkiye has a population in which more than half of the 25-64 age group have not completed upper secondary education, well below the OECD average. A rough calculation with recent statistics on average life span and years spent in education, Turkish citizens spend less than three percent of their lives in the classroom. Therefore, a huge amount of their science knowledge is gained through out-of-school environments and experiments. Individuals receive much of their knowledge about science through the mass media (Gerbner et al., 1981; LaFollett, 1990). Falk and Dierking (2010) point out that “School is not where most Americans learn most of their science” (p.486) which seems to fit the case of Türkiye in terms of demonstrating the role of school-beyond science information sources and environments in promoting and developing science in Türkiye.

Proponents of situated perspective view that the high stakes standardized measures are a poor representation of learning as higher order skills are not easily measured by multiple-choice tests (Resnick & Resnick, 1992). With this in mind, it is obviously clear that Turkish students do not perform well especially in science and math domains in those exams (national high stakes exam (SBS) and international benchmarking studies like PISA and TIMMS). Türkiye ranked the 33rd among 38 countries in the science domain in TIMMS 1999 and 31st among 49 countries in TIMMS 2007, respectively. Turkish students also do not do well in PISA tests. Türkiye ranked 47th among 57 countries in PISA 2003 and ranked 43rd among 65 countries in PISA 2009. Although there seems to be an increase in the average scores and in their ranking over the years, Türkiye still does not go further than level two in science and math domains which might be an indication of low level of science competence among the primary and secondary school students.

According to students, science is “hard” “boring” and “not important for real life” (Stocklmayer, 2001, p.18). “There is therefore a need for resources and methods of teaching that facilitate a deep understanding of science in an enjoyable way” (Negrete & Lartigue, 2004, p.120). Emphasizing the importance of school-beyond activities in science learning, Gordon, Brigdlall, and Meroe (2004) maintain that schools fail to do this. Science learning is guided by educators. Textbooks are reflecting a certain approach and educational philosophy. Newspapers, TV, and radios do not replace formal science education but this does not mean that they do not have value for science learning. Gilbert (2008) notes that science education fails to keep itself up to date with progress in science, or it does so only slowly. Gordon et al. (2004) claim that schools cannot do this alone, and collaboration with other disciplines might be needed accordingly.

Science communication as a recent field "has arisen wherever scientists, science journalists, public relations consultants, and science policy workers perceive a gap between their sense of science and its importance, on the one hand, the public perceptions of science, on the other hand" (Sless & Shrensky, 2001, p.97). Science communication and science education, as two different disciplines, have their own unique features and dynamics. Yet, they seem to serve each other (Neuman, 1981; Tichenor et al., 1970). Therefore, the idea of bridging the two would be rational as Negrete and Lartigue (2004) suggest:

> Despite the differences between science education and science communication (audience, theme, mode of delivery, agenda and institution involved), these two disciplines have many points of connection (p.120).

Educators and researchers have begun to understand that science learning is a lifelong process. Indeed, learning is a lifelong process, and science learning is a crucial part of this movement. Museums, science centers, broadcast and print media, internet, school (textbooks, teachers), family, and peers could be regarded as significant contributors to science learning (Dierking, 2005; Fenichel & Schweingruber, 2010). When people have completed their formal education, school-beyond learning environments such as science cafes, science centers/museums, and sources that are prominent in science communication field like the mass media become the main avenues in bringing science to people. Outside the school, the media are the most available and sometimes the only source to gain information about scientific issues (Bubela et al., 2009). Discussing the connections between science communication and science education through their prominent sources, this study aims to examine the various SIS with an aim to support science learning.

Taken together, in the light of the literature presented above, the rationale for this study is based on four strands: To begin with, childhood experiences are significant contributers to adult participation in science, secondly, 4th and 5th graders are defined as "critical ages" in science education. Next, Turkish students do not perform well in science domain in both national and international exams, and finally, different sources and contexts can be/should be used together in promoting science learning. In that sense, an in-depth exploration of the 4th and 5th graders` use of school-based and school-beyond sources in light of primary school students`, their parents`, and their teachers` views could provide insights into a larger picture of sources of science knowledge and potential influence on science learning.

The concept of science communication is mostly taken into consideration within adult education context, and has not been sufficiently applied to science education at the school level. However, science communication is also significant in children learning science not only as they are outsiders of the scientific community but as they are potential insiders, namely, young scientists in waiting. (Bell, 2008). Therefore, this study investigates students` science information sources in connection to their science learning processes. An in-depth understanding of the factors in, or drivers of young students` usage, interest, and interaction with various science information sources will provide valuable insights into science communication and science learning processes at the primary school level.

1.2. Purpose of the Study

The purpose of the study was to examine the features of SIS and identify the meaningful sources and uses both school-based and school-beyond contexts. In line with this, the study aimed to answer the following research questions:

1. What science information sources do the 4th and 5th grade students use in learning science?

2. How do students use various science information sources to learn science?

3. What features or uses make those science information sources effective or ineffective in students` science learning?

1.3. Significance of the Study

One of the most difficult challenges for science education "is that science education should be for all the children" (Duschl, Schweingruber, & Shouse, 2007, p.7). Duschl et al. further continue to argue the difficulties in science learning in schools:

> (…) science curriculum and instruction does not provide the kind of support for science learning that results in deep understanding of scientific ideas and an ability to engage meaningfully in the practices of science. In sum, science education as currently structured does not leverage the knowledge and capabilities students bring to the classroom. For students from diverse backgrounds, this problem is even more profound (p. 8)

Departing from the deficiencies in formal school learning, at the questions that establish the core this study are the following: How should science education and science communication be aligned for robust science learning? What are the meaningful sources in students` science learning? What do effective science information sources look like? and What can be done to ameliorate them?

People learn science in different contexts and draw on multiple sources. Uses and purposes of the sources differ across the contexts. There are many studies focusing on adults` use of various sources (National Science Board, 2012); however, we know less about how children utilize these sources. This is a science education and science communication based multidisciplinary study attempting to develop insights into the sources which the 4th and 5th grade students mostly use in learning science in school-based and beyond contexts (e.g., TV, internet, newspapers, magazines, books, parents, teachers, scientists, peers, science centers and museums, science exhibitions, science camps) and the features that make these sources interesting, enjoyable, and appealing for students. In order to understand which science learning sources and processes both in-school and outside of the school are meaningful, students`, teachers, and parents` ideas were taken into account. In doing this, the study aims to provide valuable insights for curriculum developers, policy makers, and teachers who are interested in using the dynamics of science communication in relation to the new perspectives, approaches, and efforts in strengthening the quality of SIS in bringing science to students.

Conducting a study in this subject and specifically in science education and science communication fields is essential as there exist problems in both fields. Science communication promoters sometimes blame science education: "If the subject (science) were only taught better (in schools)…we wouldn`t have to worry about the public" (Stocklmayer, 2001, p.144). Furthermore problems in science education such as the decline in science-interest among school age children (Baykul, 1990; Breakwell & Beardsell, 1992; Buluş-Kırıkkaya, 2011; Catsambis, 1995; Chapman, 1997; Gilbert, 2008; Hofstein & Welch, 1984; Piburn & Baker, 1993; Pell & Jarvis, 2001; Sorge et al., 2000; Weinburgh, 1998); adapting the science education to the challenges of the 21st century, weaknesses in science education (Appelbaum & Clark, 2001; Blades, 2001; Gilbert, 2008) like insufficient teachers, overcrowded classrooms, exam-based assessment, inadequate physical conditions, and the broken link between other disciplines (Özden, 2007) were the other motivation points to conduct this study.

In studying science education and science communication researcher does not claim: "Every child or person in the world should have an interest in science." However, installing deference to science or informing people about what is happening around the science world in the most effective way is usually marginalized in the literature (Brossard & Nisbet, 2007). Evidently, it is because "in the modern world, some knowledge of science is essential for everyone" (Duschl, Schweingruber, & Shouse, 2007, p.34). In parallel with this, authors of the Royal Society Report stated that (as cited in Driver et al., 1996):

> Everybody needs some understanding of science, its accomplishments and its limitations, whether or not they are themselves scientists or engineers. Improving that understanding is not a luxury: it is a vital investment in the future well-being of our society. (p.10)

Children as our future are considered to be the key actors in both science education and science communication but rarely directly mentioned in science communication studies. In order to stimulate students` interest in science, known but unnoticed sources may be capitalized in stimulating students` interest in science. In line with this, this study also aims to uncover maybe those known but unnoticed ways of "accessing science." Decades of literature discuss various science information sources in science learning. Yet, there exist limited studies examining connections between science education and science communication towards science information sources.

Moreover, this study will hopefully help relate science communication to science education in Türkiye. While filling a gap in the literature, this study also aims to encourage science teachers, educators, researchers, media, science center's staff, and the MoNE on the utilization of various SIS in fostering science learning. The implications of the study will focus on practical applications and suggestions for further research on science education and science communication based on the findings of the study.

1.4. Definition of Terms

Science Information Sources (SIS): A variety of science information sources may have been suggested in science learning. This study will use the definition suggested by Butt, Clery, Abeywardana, and Phillips (2010), Falk, Randol, and Dierking (2008), Lewenstein (2001), and Osborne and Collins (2000) who saw science information sources as any source providing science related information and perspectives such as sources in formal school environment (teachers, textbooks, classmates, and educational programs), and sources beyond school such as museums, science centers, TV, newspapers, radio, books, magazines, the internet, scientists, clubs, camps, families, and peers.

School-Based Sources: Sources which students mainly benefit in school contexts like textbooks, teachers, classmates. In this study researcher abstained from using the terms "formal" and "informal" in identifying the different science information sources. It is not only because of the conflicts in defining the terms (Hofstein & Rosenfeld, 1996; Friedman & Mappen, 2011), but also because of the 4th and 5th graders` experiences in using those sources. In the study, students did not limit their use of particular sources to the formal and informal contexts. Moreover, the present study did not focus on seperating and examining the sources in different contexts. Researcher believes that classifying learning into seperated fields like formal or informal is not helpful as also discussed by Billett (2002), Hofstein and Rosenfeld (1996), and Fenichel and Schweingruber (2010).

Beyond School Sources: Sources which students mainly use beyond school contexts like newspapers, science magazines, science museums, scientists, families, science camps, and science exhibitions.

Science Communication: Science communication, as a very recent field with a fertile ground in the context of research, is effective in transferring the scientific information and promoting interest and awareness in science. Science communication is defined as “the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science: Awareness, Enjoyment, Interest, Opinion-forming, and Understanding” (Burns, O’Connor, & Stocklmayer, 2003, p. 183).

Science Learning: Science learning is multifaceted. “Research on learning science makes clear that it involves development of a broad array of interests, attitudes, knowledge, and competencies.” (National Research Council, 2007, p.25). National Research Council’s *Taking Science to School* (2007) and *Learning Science in Informal Environments* (2009) reports provide a framework for science learning with six strands: (1) Developing interest in science, (2) understanding and using scientific explanations, (3) generating scientific evidence, (4) reflecting on the scientific enterprise, (5) engaging in scientific practices, and (6) identifying the scientific enterprise.

CHAPTER II

REVIEW OF LITERATURE

(...) young people, the scientists of the future...

Wilkinson, 2010, Science and the Citizen

In this chapter, the literature on science information sources regarding the perspectives of science education and science communication theories is presented along with students` use of these sources in learning science.

2.1. Theories Guiding The Research

In this part, the situated learning theory from science education and uses and gratifications theory from science communication are discussed as two major theories guiding this study.

2.1.1. Situated Learning Theory: Theory of Science Education

Having influenced by Vygotsky`s social development theory and Dewey`s instrumentalism, Jean Lave`s situated learning theory assumes that (Leonard, 2002):

> (…) learning experience as a shared, social, almost unintentional learning event. In situated learning, the learners participate in a *community of practice.* The social interaction process that occurs between new comers and old-timers within the community of practice is referred to by Lave as *legitimate peripheral participation.* (p.174)

According to Brown, Collins, and Duguid (1989) situated learning theory does not put forward a separation between knowing and doing. Knowledge is not independent from the situation in which it is learnt and used. In other words, knowledge cannot be abstracted or decontextualized from the situations in which it occurred since it limits the effectiveness of such practices. Wilson and Myers (2000) describe situations as cognition principles relating to learning environments. They assert that thinking, learning, and condition make sense only within particular situations. Moreover, learning requires active participation as well as interaction with other people, tools, and physical world. Explaining the importance of the past experiences, Wilson and Myers (2000) maintain that:

> Situations make sense within a historical context, including the past experiences and interactions of participants, as well as anticipated needs and events (p.71).

In line with this, Wilson and Myers (2000) maintain that people`s identities and constructions of self serve as tools for thinking and activity. Emphasizing the association between activity, concept, and culture, Brown et al. (1989) claim that no one can be totally understood without the other two, which means that learning must involve all three dimensions listed above. Henning (2000) puts forward three advantages of taking this approach for this research. The first advantage is situated learning abolishes the artificial lines between school-based and school-beyond science learning. In this approach, learning is seen as a practice based approach which is always situated in a particular context such as school, home, etc. Next, it enhances a comparative research activity which examines that learning is situated in culturally and socially diverse locations. For illustration, in the current study, science learning was examined in different school types and somehow compared between public and private schools as well as between two different grades. A third significant advantage of taking a practice-based approach is that it brings the known but sometimes unnoticed physical and cultural dimensions of the learning into the analysis.

2.1.1.1. Science Education

The launch of Sputnik in 1957 was a milestone in the history of science education. Sputnik era based science related reforms in many areas, and this movement affected not only the U.S. but also all over the world, gradually (Ornstein & Hunkins, 2004). These reforms aimed to better science education. Indeed, education, as an orderly and deliberate effort, required some plans to guide this effort (Saylor, Alexander, & Lewis, 1981).

Knowledge plays an important role in shaping people's opinions and attitudes about science and technology (Scheufele, 2006). Wilkinson (2010) asserts that people who are good at science at school, and continue to study science subjects for a while have a better recall for science information from their past and a greater versatility to learn new science issues that they didn`t learn in their earlier education.

There is an important argument that school science significantly contributes to improving public understanding of science (Driver, Leach, Millar, & Scott, 1996). However, there seems to be sufficient evidence demonstrating that most of science is learnt outside of the school (Falk & Dierking, 2010). In other words, science is learnt outside of the school as well as inside of the school. Differentiating the school based and beyond sources in science learning, Gallagher (1991) states that:

> While the role of the media, especially television is in forming the image of science may be very important, it is schools that have the opportunity to influence the image of science held by all of our citizenry, since all youth are required to enroll in science during their junior and senior high school years (p.121).

National Education Statistics for 2010-2011 academic year shows that, Türkiye has a large number of primary education students (10.981.100) with limited schools (32.797), classrooms (339.653), and teachers (503.328). In addition to this in-balanced distribution in this picture, when regional, cultural and socio-economical differences and inequalities included, Turkish students do not do well in science in both national (SBS) and international benchmarking exams (TIMMS, PISA). Furthermore, although even the U.S. is considered as a world super power and leader in science and technology; school aged children are behind children in other countries in science knowledge (Falk & Dierking, 2010; Schmidt, McKnight, & Riaizen, 1997). This is both true for national and international tests (NAEP, TIMMS). As a result, schools cannot develop science knowledge alone as Gordon et al. (2004) suggest.

2.1.2. Uses and Gratifications (U&G) Theory: Theory of Science Communication

Uses and Gratifications (U&G) theory suggests that media users play an active role in choosing and using the media that best fulfills the needs of the users. According to O'Donohoe (1993):

> (…) the mass media constitute a resource on which audiences draw to satisfy various needs. In its conception of an active, goal-directed audience; it is consistent with emerging views of the advertising consumer (p. 52)

This theory puts forward that people use the media content to fulfill their gratifications. It also holds that audiences take an active part in choosing and using the appropriate sources to meet their needs. Katz, Gurevitch, and Haas (1973) list 35 basic human needs based on an extensive analysis of the literature and classify them into five categories:

> (1) Cognitive Needs: Strengthening information, knowledge, and understanding
> (2) Affective Needs: Strengthening aesthetic, pleasurable, and emotional experiences
> (3) Personal Integrative Needs: Strengthening credibility, confidence, stability, and status
> (4) Social Integrative Needs: Strengthening contact with family, friends, and the world
> (5) Tension Release Needs: Escaping and diversion (p.166).

In addition to the abovementioned needs classification, Katz, Blumler, and Gurevitch (1973; 1974) present five elements of the theory:

(1) It proposes an active audience.

(2) It has an initiative focus on the link between uses and gratification and audiences` choice. In other words, audience is emphasized rather than the source itself.

(3) In order to address the diverse audiences` needs, the media should take into account other alternative, different, or conventional ways of communication forms.

(4) Self-reported interests, motives, and experiences of the audiences are typically taken into account in methodology which has traces of qualitative approaches.

(5) Since audiences` own experiences and adaptations are important, value judgments about cultural differences should be avoided analyzing.

2.1.2.1. Science Communication

Rapid changes in philosophy, society, science and technology also have led to different perspectives in science, such as the birth of science communication as stated by Sless and Shrensky (2001):

> Not surprisingly then, something called Science Communication has arisen wherever scientists, science journalists, public relations consultants, and science policy workers receive a gap between their sense of science and its importance, on the one hand, and public perception of science, on the other hand (p.97).

Science communication is a young growing area of practice and research (Burns et al., 2003; Stocklmayer, Gore, & Bryant, 2001); however, science communication has developed dramatically in the last decade (Burns et al., 2003; Gregory, 2009). It is widely accepted that "communicating science is important but is not effective as it could be" (Treise & Weigold, 2002, p. 310), even it is not known well in Türkiye (Arca, 2004).

Science communication has been a popular concept in Europe over the last decades (Kurath & Gisler, 2009). Different definitions seem to be attributed to the definition of the science communication. Burns et al.`s (2003) perception of science communication is related to its productive nature of awareness, enjoyment, interest, opinions or understanding of science. Stocklmayer et al. (2001) state that "Science communication concerns the relationship between science and society, and it has a powerful role in shaping this relationship and also in what science is done and how it is used…" (p.83). From the viewpoint of Burns et al. (2003) science communication is,

> the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science: Awareness, including familiarity with new aspects of science; Enjoyment or other affective responses, e.g. appreciating science as

> entertainment or art; Interest, as evidenced by voluntary involvement with science or its communication; Opinions, the forming, reforming, or confirming of science-related attitudes; Understanding of science, its content, processes, and social factors. Science communication may involve science practitioners, mediators, and other members of the general public, either peer-to-peer or between groups (p. 191).

Nelkin (1995) defines the mission of the sources of science communication as “selling science.” But, according to Stocklmayer et al. (2001), science communication is much more than selling science to the public. They elaborate on this by stating that there exists a heterogeneous structure in public with its culture, socio-economic status, personality, and experience. Furthermore, they claim that science communication has a powerful role in shaping this relationship in a scientific context considering science policy issues. Conversely, Treise and Weigold (2002) handle science communication in a broader context and they assert that the mission of science communication is beyond just informing people about what is happening in science. They assert that:

> Science communication can provide the public with information essential to forming opinions about public policy and about the costs and benefits of governmental expenditures on science (p.311).

Explaining science communication through the ages, Hannam (2011) states that “the history of science communication is the story of how scientific practitioners have attempted both to educate the public and to project a positive image of themselves” (p.31). He names the historical terms with seven different names as described below:

(1) Science as Status- The ancient Greeks: Philosophers and scientists did not need to share their ideas with the public as long as their work are very impressive.
(2) Science as Art- The Romans: Romans` domination on Greek world.
(3) Science as Handmaiden- The Middle Ages: Science was a handmaiden to theology.
(4) Science as Reform- The Early Modern Era: The trend towards science accelerated with increasing numbers of books in the sixteenth century.
(5) Science as Entertainment- The Eighteenth Century: People were willing to see scientific demonstrations with amusement and entertainment in it.
(6) Science as Progress- The Nineteenth Century: People came to realize the importance of science to them and applied science became a reality.

(7) Science as Profession- The Tweentieth Century: Science became a career option, new institutions like science centers and museums appeared (pp. 31-44).

Science communication has shifted from one-way deficit models to interactive democrative models through decades. According to Perera (2009) this shift has been parallelled in science education since student engagement with science is promoted in science education, too. Science communication has a more interdisciplinary approach in this bio-nanotechnology world. In his article, Lewenstein (1992) examines the historical perspectives in the U.S. after World War II. He notes that in the 1940s the terms *public understanding of science* and *public appreciation of the benefits that science* provides to society resembled to each other in the U.S. A new era for popular science began after two decades with collaboration of four different groups: publishers, scientific societies, science journalists, and government which fits to the Dorothy Nelkin`s definition of *contemporary situation of science*.

Lewenstein (2003) discusses four key perspectives in public communication activities, namely: deficit model, contextual model, lay expertise model, and public participation. Firstly, the deficit model approaches public as a passive receipent with a lack of knowledge. Therefore, this model does not seem to be successful and the following three models are considered a kind of response to deficit model. Secondly, the contextual model assumes that individuals shape the information by their previous experiences and social and personal characteristics. In other words, individuals have an active participation in processing information rather than being empty containers of information. This model is also criticized for being just a sophisticated version of the deficit model. The last two models emerged based on the acceptance of the importance of local knowledge and commitments to political inclusion and participation in the mid 1980s. Accordingly, the third model, namely the lay expertise model, proposes that knowledge is based on the lives, cultures and histories of the communities. Lewenstein (2003) criticizes the model since it privileges local knowledge over the reliable knowledge. Lastly, the public participation model highlights the concept of public engagement through *democratizing* science. However, this model is criticized as it focuses on individuals, and process of science but not content, serves a small number of people, and has an "anti-science" bias. On the whole, science communication used to be conducted through a deficit model, a one way communication from experts to public, and now it uses a dialogue model that engages public in two way communication (Trench, 2008).

Barjak (2004) suggests two different types of science communication: formal and informal communication. In his definition, formal communication is impersonal, robust, and reliable piece of information which takes places in books and journals. On the other hand, informal communication is personal and social like the communication through e-mails, between partners, close co-workers, and friends. It is important to note that "scientific information communicated informally is less robust and more redundant than information communicated formally" (Garvey, 1979, as cited in Barjak, 2004).

Moreover, Mulder, Longnecker, and Davis (2008) and Wilkinson (2010) comment on science communication's interdisciplinary or multidisciplinary nature. Illustrating four disciplines that science communication is related to (science, educational studies, social studies of science, and communication studies), Mulder et al. (2008) claim that science communication tends to cover these four supporting disciplines to some extent in their curricula by asserting that "Science communication is a relatively new discipline and is, by its very nature, interdisciplinary" (p. 279). Figure 2.1 illustrates four disciplines that science communication is related to. According to Mulder et al. (2008), science communication tends to cover these four supporting disciplines to some extent in its curriculum.

Although the literature proposes multidisciplinary models for science communication with educational studies, there exist disconnections between science communication and science education (Nisbet et al., 2002) which will be discussed later.

The utmost aim of the practices of science communication is generally that someone will learn something about actual facts or concepts, science, technology, and society, or ideas about how science works. In line with this, science communication focuses on the dialogues between scientists, policy makers, and lay people (Turney, 2009; Wilkinson, 2010). Wilkinson (2010) adds that science communication has also a mission like understanding the reforms and incentives for current educational provision in the formal education agenda and providing a perspective on how young people develop their insights apart from helping us formulate effective and meaningful projects.

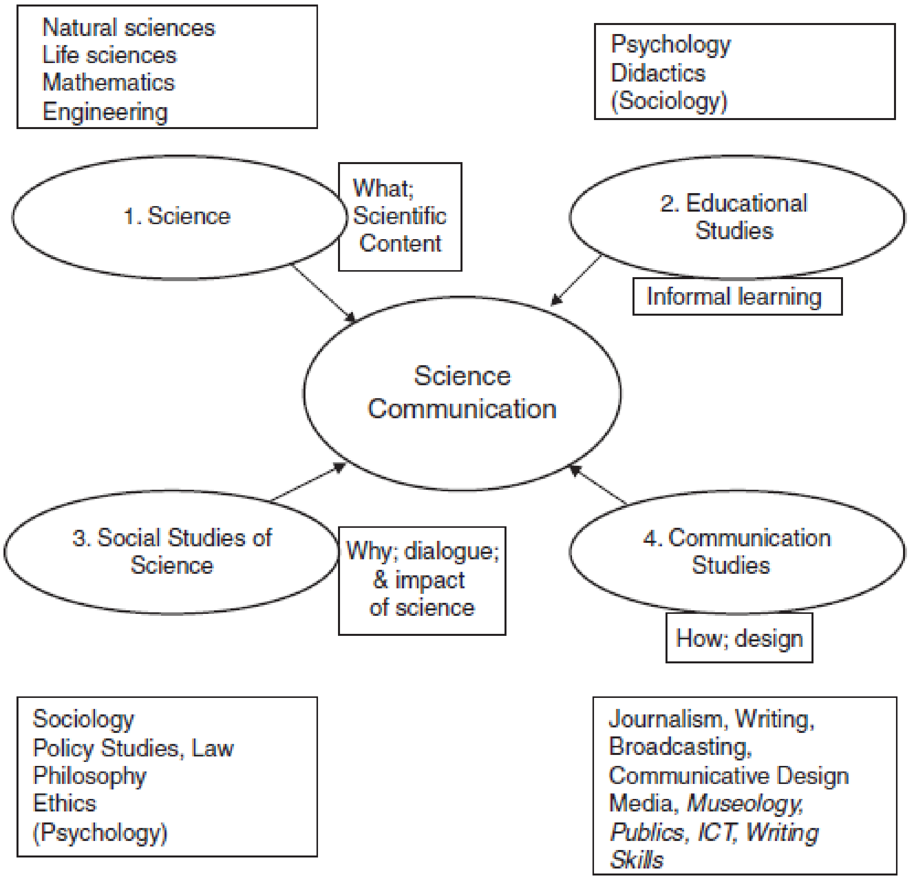

Figure 2.1. Four areas of study that support the discipline of science communication. Reprinted from "The State of Science Communication Programs at Universities Around the World," by H.A. Mulder, N. Longnecker, & L.S. Davis, 2008, *Science Communication*, *30*, p. 280. Copyright 2008 by the Sage Publications. Reprinted with permission.

Within this context, Wilkinson (2010) explains the role of science communicators to support learning about and interest in science:

> Science communication does not occur in isolation to that which occurs in formal science education settings, and as we have seen in the earlier attitudinal data, education seems to play a key role in both the ability and

> enthusiasm to participate in informal science learning later in life. There may be an educational element to many science communicators' projects and thinking about ways to develop creative, innovative and inspiring activities that support young people whilst in education and continue that interest in science later in life appeals to many science communicators (p. 67).

2.1.2.1. Why Science Communication is Important?

During the history, scientific, and technological developments have affected every single nation in the world directly or indirectly, slowly or fast according to their developments. In the recent years, the changes in scientific and technological issues have been so dramatic that it is even difficult to follow them. Accordingly, the scientific knowledge should be transferred as fast as possible to catch up the latest science in this new information age.

Communicating the facts and principles of science to the public has some benefits, categorized by different researchers somehow in a similar fashion. In the first place, Stocklmayer et al. (2001) handle this in five titles, namely: *economic argument* in wealth creation; *utility argument* for coping with aspects of modern life*; democratic argument* for participating effectively in modern democratic processes*; social argument* to be accountable to that public and explain what they are about; and *cultural argument* as a part of culture as art and music. Next, Laetsch (1987) explains the claims in priority, orderly: making better political decisions; understanding the basis of modern technology; promoting national security; eliminating superstition and non-rational views of the universe; improving behaviour; and leading to a more ethical world view. It is not guaranteed that children will be experiencing all these benefits of science communication but they still may appreciate the science, see science inside modernity, and start to eliminate scientific ideas and non-scientific ideas.

Unless shared or reported to the world, whatever scientists think or discover individually cannot be regarded as belonging to scientific knowledge (Gregory, 2009). If scientific knowledge has a meaning when it is shared in some way, then science communication is necessity in science. To put in another way, if until recently communicating with people was optional, today it seems as a necessity (Carrada, 2006). What is more, the poor understanding of science by young people in international and national exams could be regarded as a proof of necessity of science communication in today's world. "So science, to deserve the name, must be communicated" (Gregory, 2009). In line with this, Ziman (1984) verifies this idea: "The fundamental social system of science is thus its system of communication" (p.58).

2.2. Marriage of Science Education and Science Communication

During the past two centuries, science has grown so rapidly that it has fragmented into various fields, disciplines, and sub-disciplines. Parallel with this, the public understanding of science has evolved into a dynamic, interdisciplinary sphere not only researchers but also policy makers (Pardo & Calvo, 2002).

Gregory (2009) states that science happens everywhere whether in a lecture hall or over dinner. He also supports his idea with what Collins and Pinch (1979, as cited in Gregory, 2009) suggest within the framework of science learning:

> While it can be easy to categorize a communication as formal or informal, it is less easy to see any clear advantage of one over the other as contributing to scientific knowledge: the intellectual and practical activity that is science is happening in both places (p.9).

Science information sources (SIS) including TV, radio, newspapers, magazines, science centers, science and technology museums, zoos, botanic parks, etc. are counted as informal science learning environments in the area of education; however, they seem to be "overlooked in science learning" (Ramey-Gassert, 1997). An old-fashioned view that "science is learnt in schools with teachers, textbooks" sometimes finds a space itself in minds, but it is clear that science is independent of all contexts and frames. School based science learning environments are at least as effective as school beyond contexts. "Informal learning should no longer be regarded as an inferior form of learning whose main purpose is to act as the precursor of formal learning" (Coffield, 2000, p. 8). Informal sources are somehow supportive to formal sources because science learning should not be simply under the responsibility of the formal schools. Emphasizing the importance of beyond school activities in learning, Gordon et al. (2004) also maintain that schools should be supported with different learning contexts as people diverse with different backgrounds, characteristics, and frames, and arranging K12 science education with mediation of different learning contexts seem to serve better to the needs of this audience. Another remarkable point is: “Average Americans spend less than 5 percent of their life in classroom” (Falk & Dierking, 2010, p.486). That is actually to say a huge amount of science knowledge is gained through the school beyond informal learning environments.

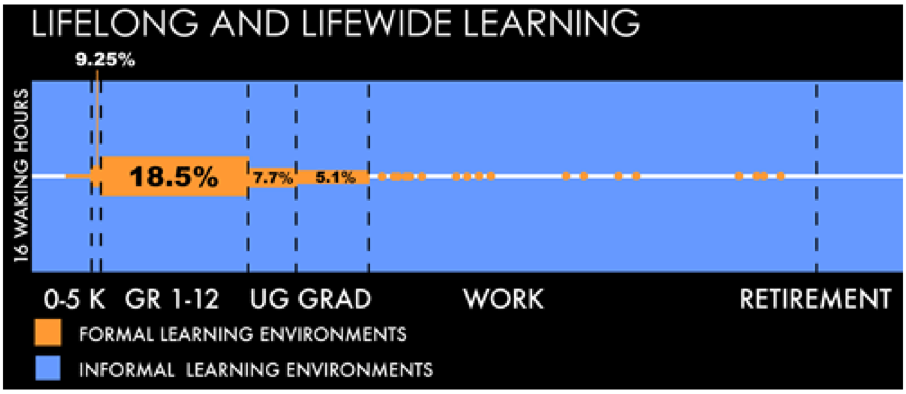

Figure 2.2. The Life Center lifelong and lifewide learning diagram. Reprinted from *LIFE Center http://life-slc.org*, by R. Stevens, J. Bransford & A.Stevens, 2005. Copyright 2005 by Creative Commons Attribution-NonCommercial-NoDerivs 3.0 United States License.

Note. This diagram shows the relative percentage of their waking hours that people across the lifespan spend in formal educational environments and other activities. The calculations were made on the best available statistics for a whole year basis on how much time people at different points across the lifespan spend in formal instructional environments.

Figure 2.2 indicates the relative percentage of people`s waking hours across their lifespan spent in school environments and other activities. The calculations were made on the whole year basis on how much time people at different points across the lifespan spend in formal instructional environments.

K12 science education seems to serve science communication while preparing students for after-school life. “Basic constructs are rarely explained in current media in sufficient depth to foster basic understanding, most individuals must rely on previous formal and informal education for their basic inventory of scientific constructs” (Miller, 2004, p.6). Miller asserts that an individual`s understanding of science may depend on his/her understanding of basic concepts or constructs. Education serves as a catalyst that affects public conceptualizing of various subjects (Neuman, 1981; Tichenor et al., 1970). However, after completing the formal science education, the media becomes the most available and sometimes the only source for the public to gain information about scientific issues (Nelkin, 1995).

The media has an important influence on attitudes toward science (Lee & Scheufele, 2006). There seems a remarkable mutual effect between the media as an informal educational source and education. How education contributes to adult life is a question that is explored through some research (Bell et al., 2009; Elsley & McMellon, 2010; Oskala et al., 2009). Scholars in science communication and educators talk about *hows* in bringing science to people rather than *whys* since *whys* are crystal clear in economic, democratic, social, cultural, and political meaning as explained by researchers through decades. Around the question on *how*, both in communication and education literature, effective methods to transfer the information or message are discussed. In education, there exist some methods or theories which science education teachers may use in strengthening their instruction. On the other hand, in science communication, using various sources in communicating the message, effective communication strategies, risks, multidisciplinary studies like climate change, nanotechnology, and genetically modified foods are prominently discussed (Gaskell, Stares, & Kronberger, 2011; Lock, 2011).

There exist many similarities and differences between science education and science communication as shown in Table 2.1. Science is communicated throughout life; it does not have an exact starting or an end point like formal science education. Through formal education stages and when formal education is completed, people continue to learn science. In line with this, science education mainly focuses on school-based contexts with teachers and textbooks while sources in school-beyond contexts like TV, internet, newspapers, science centers, and museums are mainly attributed to science communication. Indeed, studies from the both disciplines indicate that these two contexts with sources are highly effective in bringing science to the audiences. Typically, the audience in science education could be considered school-age children whereas adults constitute the audience in science education. It is crystal clear that children are the common audience for both disciplines but are mainly overlooked in science communication.

Table 2.1.

Differences and Similarities Between the Practices of Science Education and Science Communication

	K12 Science Education	Science Communication
Differences		
Aim	The basic principles, scientific explanations, scientific literacy	Awareness, enjoyment, interest, opinion-forming, and understanding
Audience	School students	People from all ages
Ground	Curriculum based	Non-curriculum based
Participation	* Compulsory in schools	Voluntary
Assessment	Assessed	Not-assessed
Learning processes	Guided	Self-directed and sometimes guided
Understanding background of the participants	Typically known	Not well-known
Similarities		
Outcomes	Intended or unintended outcomes	Intended or unintended outcomes
Sources	Usually in-school, out-of-school sources	In-school, usually out-of-school sources
Frames	Students` needs and frames	Audience`s needs and frames

Note. (*) The ages for compulsory education vary by country.

The issue of *how messages are framed* and *communicated to audience* through the SIS is under discussion by many researchers in the field of science communication. For example, Bultitude (2010a) claims that tailoring the message to the audience is important since the message is more effective if linked to participant needs and interest. Furthermore, participants are more receptive if the content is at the appropriate level. This is not only true for science communication but also for science education. Accordingly, in presenting the content in science education it is mainly recommended to progress from known to unknown, simple to complex, and concrete to abstract.

"Framing is an unavoidable reality of the science communication process" (Bubela et al., 2009, p. 515). For effectively framed science communication, it is necessary to understand diverse audiences` schematas (Scheufele, 2006). Frames are little tacit subjective theories about "what exists, what happens, and what matters" (Gitlin, 1980, p.6).

In other words, frame is a word used for cognitive structures which are based on people`s pre-existed experiences, values and beliefs to make sense of an issue or reason it. Here, it is important to note that, the same message about a science issue may be conceptualized very differently by different audiences (Scheufele, 2006). Messages, therefore, should be arranged in line with people`s schematas, or understandings.

The literature regarding science communication indicates that science communication is important in enhancing enthusiasm, wonder, eagerness, interest, and attitudes towards science while embracing people from all over the ages. There exist various studies related to the science communication with a strict deficiency and a need for comprehensive research in Turkish context. In addition, in both national and international studies there is limited research focusing on science education and science communication elements at the same time. In one of the studies, Perera (2009) investigated one-day workshops offered to 66 middle school science teachers from outside Australia (Sri Lanka and Indonesia) in Canberra, Australia using qualitative methods. Data were collected through interviews conducted with workshop participants and workshop facilitators, and observations held during the workshops. The results of the study indicated that the workshops did facilitate conceptual change in the teachers and the constructivist principles in the workshops` design and delivery were underpinned by science communication practices. In addition, the conclusions included the possibility of a constructivist framework for short-term professional development, the need for greater involvement of science communication in science education, and the unique challenges which confront science teachers from non-Western cultures.

2.3. Science Information Sources (SIS)

In the literature of science education, both science information sources and contexts are sometimes categorized as in-class and out-of-class sources/environments, or formal and informal sources/environments (Colley, Hodkinson, & Malcolm, 2003; Fenichel & Schweingruber, 2010; Friedman & Mappen, 2011; Hofstein & Rosenfeld, 1996; Lewenstein, 2009). Informal learning environments are sometimes named as *free-choice learning* environments (Falk & Dierking, 2000; Falk, 2001). Similar categories are also available in science communication. Elsewhere, Gregory (2009) notes that science is done by informal rather than legitimate formal communication. For Weitkamp (2010), media science information sources are fictional (i.e. novels and films) and non-fictional (i.e. newspapers, magazines, and internet). Sometimes media information sources are categorized as traditional (i.e. TV, radio, newspaper, magazines) and as new/alternative media (internet) (de Semir, 2010).

“Although children bring a wealth of resources to the science learning task those resources must be built on, enriched, and transformed if they are to learn science with understanding” (National Research Council, 2007, p.214). Yet, there is a traditional misconception that science education is limited with formal contexts, and science communication takes place in informal contexts (Gilbert, 2008). Highlighting the differences between the prominent sources of school science education and science communication, Gilbert (2008) further claims that:

> The first is the use of “context-based” courses within formal provision. The second is the much greater use of informal provision, namely that made through museums zoos and botanical gardens, TV, the internet, newspapers and magazines, books. (p.3)

So far, this chapter has focused on science education, science communication, and introduction of science information sources (SIS). In the following paragraphs, the literature related to some of the science information sources like media sources, books, teachers, families, and science centers/museums is presented in detail.

The changes in the sources bring about changes in audiences` preferences. For instance, National Science Board (2012) report that adults and younger people differ in their uses of SIS. According to the report, younger audiences mainly use internet for news and information, including science and technology information, and their use of the internet increased with education level and income. Surprisingly, the use of TV decreases with education and income while it increases with age. When it comes to the primary source of information that people use about the current news events, science and technology and specific issues between 2001 and 2010, printed newspaper readership has declined over the past decade, and TV use has also declined but relatively little when compared with newspapers. Conversely, internet has become a dominant source in current news, science and technology, and specific issues.

To begin with, books are important in science since they provide public debate or public argument, and have cultural importance by making science exciting, accessible and connected with other issues in public life (Lewenstein, 2009). Reading rates in Türkiye are behind the European countries and Japan. Textbooks are the main sources used by young children, and the children typically do not have a tendency to read other books rather than textbooks. In this part, science textbooks which have an obligatory nature and other scientific books are presented seperately based on the interpretation of the researcher. In Türkiye, public schools have common textbooks for different grades which are distributed to students free of charge at the beginning of the school year by the Ministry of National Education (MoNE). In private schools, some schools may have their textbooks published as different from the books of MoNE but they have follow the plan indicated through the national curriculum. Lewenstein (2009) points out that “The power of textbooks is their ability to create communities of people with similar training similar perspectives, and similar tools” (p.155). It seems obvious that when the power of the textbooks is not used efficiently in science instruction, then they might not serve their purposes and could be regarded as useless sources. As also highlighted by National Research

Council (2007): “Curriculum documents and textbooks fail to recognize the importance of children’s prior experience, underestimating both their capacities for reasoning and the difficulties posed by scientific conceptions” (p. 211).

Teachers are in best position to expand each and every child`s horizons so that science is included not excluded (Abruscato, 1992). Limited hours, curriculum to follow, tasks to do, and crowded classes sometimes affect negatively “teachers` best position” in bringing science to children negatively. This often directs teachers to apply models of instruction that are ineffective in some ways. Duschl et al. (2007) highlights the challenges of science learning as follows:

> Science learning presents a special challenge to educators because of both the diversity and the complexity of mature scientific knowledge and the fact that it rests on organized conceptual frameworks and sophisticated knowledge construction and evaluation practices that are fundamentally different from the concepts and meaning-making practices that children bring to school (p. 213).

Teachers` science field knowledge is very important in their instruction (Gallagher, 1991) and student learning of science is highly correlated with teachers` having adequate knowledge of science (National Research Council, 2007). Although there has been less research especially on the content knowledge of elementary science teachers, the existing evidence supports this thought (National Research Council, 2007).

Mass media sources as one of the main science information sources (Friedman, Dunwoody, & Rogers, 1986; Nelkin, 1995) are classified as fictional (novels, films, etc.), non-fictional sources (newspapers, magazines, internet, etc.) (Weitkamp, 2010); however, sometimes they are categorized as traditional (TV, radio, newspaper, magazines), and new/alternative media sources (internet) (Gross, 2003). Science broadcasting is an important and rapidly developing area (Murcott, 2010). Broadcast programs have visual and audio elements which are different from books and magazines. It is widely accepted that science information presented in TV, magazines, or newspapers is more entertaining than it was in the past. The transition in media coverage seems to change audiences` preferences as well. According to the Ministry of Family and Social Research

(SAGEM) (2008), research on the "Usage of Internet and Family", the internet, TV, and telephone are the most used media devices among young children. Turkish Statistical Institute Report (TUIK, 2011) indicates that 42.9 % of the population uses internet. In Türkiye, access to television is available in almost all households, whereas access to internet is much lower. Computer labs are mainly available in schools with a limited and restricted access to internet. In this new information era characterized with the internet, media sources are mainly grouped into two categories, namely traditional media (TV, newspapers, science magazines, and radio), and alternative/new media (internet).

Updated information on science is typically presented via the traditional media. To start with, almost every home in the developed countries and every village in the developing countries today has a TV which is a popular household (Gilbert, 2007). Scientific documentaries on the TV are the examples of factual broadcasting. In Türkiye, young people`s popular fictional TV programs like Myth Busters, Sponge Bob, and Ultimate Survive include many science components. Here, it is important to note that, there can be a tension between the accuracy of science and the dramatic requirements in fictional programs (Murcott, 2010).

Science on the TV can be characterized into two broad approaches. The first one is *obvious*. This approach is characterized with the documentaries or other direct programs in which science is the main event. The second approach is *incidental*, which means that science is indirect or backdrop behind the main content (Hook & Brake, 2010). In his study on Science on TV, Collins (1987) analyzed two science television broadcasts: "QED" on the "Shroud of Turin" and "The Geneva Event" on "BBC" for their coverage of science, features, and their messages. In his study, he further examined the transcripts of two programs, and the results indicated that the way by which such programs portray science had an effect on public understanding of science. In line with this, Collins criticizes TV for presenting unambiguous, intractable and sometimes uncertain knowledge and recommends further research. Examining science knowledge covered through the media, Hook and Brake (2010) refer to direct and indirect learnings as obvious and incidental learnings on TV. Brossard and Shanahan (2006) identified and tested thirty-one terms that are most often used in the media. The researchers argue that these terms represent what an individual is expected to know as well as their knowledge of scientific and technical vocabulary. In order to test the terms they came up with, the researchers used National Science Foundation`s scale, which is the most widely cited public scientific literacy measurement instrument. Through their study, there was not sufficient statistical evidence to conclude that either newspaper use or television exposure was related to scientific literacy. However, they found a positive relationship between media scientific literacy and scientific literacy when controlling for age, gender, and science education. Parallel with the results of their study, the researchers recommend that since scientific knowledge rapidly evolves, the instrument should be updated every year, with longitudinal studies using only a media scientific literacy total score as a rate of comparison.

Young children as consumers of media are not passive receipents of science information (Tomlinson, 1991). Türkiye, as a country with a focus on TV and increasing internet usage at home, has a moderate use of the new technologies. In this picture, radio, newspaper and magazines are left behind of the TV and internet usage. Different family structures and education systems between countries shape different opportunities and constraints in terms of children's leisure time experiences such as restricted leisure time, privatization of the media use, inequalities of access to new media in the home (different levels of socio economic status), and parental control over access to media (Buckingham, 2002).

Internet is mainly conceptualized as *new* or *alternative* media. People use internet to acquire science information in order to meet their immediate personal, social, and economic needs (Selwyn, Gorard, & Furlong, 2006). For Bubela, et al. (2009), internet, as a major source of science information, has both positive and negative consequences.

Montgomery (2007) presents the advantages and disadvantages of e-science. The advantages are that (a) the transfer of the information is immediate without an interruption; (b) data can be shared simultaneously with other people through graphics, images, 3D and 4D modeling, and animation; (c) electronic journals are user-friendly; (d) online articles and reports can be produced and published quickly; and (e) important talks, presentations, and lectures may be kept easily. In other words, Montgomery (2007) implies that core aspects of science have been rendered more efficiently by the internet over time. When it comes to the drawbacks of the internet, he questions the copyright and plagiarism issues which are also regarded as the main problems of teachers in terms of the reliability of information, and the perils of popularization. In brief, Montgomery (2007) concludes that online science holds more positive promises than drawbacks considering a digital online future.

According to Hook and Brake (2010), internet, as a new/alternative media source, sometimes provides unintentional information via popular sites such as Facebook, Twitter, MySpace, and You tube. However, they advocate that science learning through internet is still significant because those who have an interest, group, connection or knowledge of science may find each other easily. In a similar vein, Trench (2008) handles internet`s becoming a main element in science communication and maintains that internet communication has been thoroughly integrated into the practices of science. As a matter of fact, internet is much more helpful in accessing science information in comparison to the other media tools (National Science Board, 2004).

The internet has gradually become a research tool for science news and information. Online encyclopedias like wikipedia, audio-visual sources like youtube, and social communication sites like facebook, twitter, and blogs are mainly used among young people aged between 10-18. In this respect, new media changes the nature of science communication (Bubela, 2009) and information is at the click of a mouse.

Parents, peers, and educators have critical roles in supporting science learning (Fenichel & Schweingruber, 2010). Miller (1987) states that “the most effective source of attitudes toward science and mathematics is the family” (p. 177). According to Fenichel (2010) children whose parents ask questions during TV programs have more permanent science information in comparison to the children who passively receive information communicated through the TV. Similarly, Fender and Crowley (2007) and Crowley and Galco (2001) report the positive effects of parent conversation and explanation on childrens` learning and understanding the scientific phenomena. In their report, Bell et al. (2009) recommend parents to be alert on child`s specific intellectual interests, organize family activities that feature these interests, work with the child on the Internet or take him or her to a zoo or museum, or concoct scientific experiments with household items in order to gather more information in a supportive way to class science activities.

Science fairs and exhibitions are among the other SIS. They are typically organized for school aged students and families. In science fairs and exhibitions, students present their works which are based on a scientific subject(s). Fairs have an interactive environment and encourage participants to perform original research (Bultitude, 2010a). In Türkiye science fairs or exhibitions are generally placed in schools, science centers/museums, or shopping malls (AVM).

Science centers and museums are the last SIS that are discussed within this chapter. Exploratorium founder, Frank Oppenheimer, explains the mission of centers/museums in five aspects: hearing, touch, taste, vision, and smell. They contain many media sources like audio-visual exhibits, interactive exhibits, and two, three or even more dimensional models which may address the needs of diverse audiences. Apart from their obvious utility to stimulate science learning, science centers and museums are thought to display some disadvantages: they contain lots of technology but very little science, the materials of science illustrate the business of science, and they present scientific phenomena as simple facts without illustrating how our understanding of science develops over time (Bultitude, 2010b).

Rennie (1994) reports the results of a pilot study which devised a way of measuring effective outcomes of a visit to a CSIRO Science Education Center. Specifically, students who visited the center were asked to comment on how easy they found various aspects of the activities they did there, to what extent they enjoyed what they did, and how helpful they found the visit in terms of their wider views and understanding about science and scientists. Falk (2002) emphasizes the importance of "free-choice learning" environments (books, TV, museums) in science education. In the same line with this, Pedretti (2002) states that science centers and museums` increasingly position themselves as socially valuable resources for conveying information to the public about science and technology and their social implications.

Garnett (2002) carried out a project and explored the impact of science centers in order to collect and collate international reports and studies on the role played by science centers in their communities, to summarize and present these studies in a useful and accessible way, and to identify gaps in the studies. 180 studies including the published and unpublished reports relating to the impact of their institutions on their surrounding communities were reviewed. Most of these reports were concerned with learning/personal outcomes (87%), 54% of them focused on science learning, 18% of the reports highlighted attitudinal change towards science. According to the summary, enjoyment was found to be another focus (14%), and Science & Discovery Centers` influencing career choice was 7%. Overall, 180 papers reviewed revealed that science and technology centers and museums had a positive effect in a number of areas.

As a well known impact study on museums, Jarvis & Pell (2005) examined attitude changes of 300 children, aged 10 or 11 years, from four schools, who visited the UK National Space Centre. Five different attitudes toward science and space scales were administered before, immediately after, and 2 months and 4–5 months after the visit. Data were collected through observations during the visits and interviews conducted with teachers and a sample of children. The results revealed that the pattern of impacts was complex. There was no evidence of a long-term effect on enthusiasm for science resulting from the visit; however, there was an overall positive effect with regard to interest in space and science in society immediately after the visit. Another remarkable point was gender differences. Although boys showed a significant change in attitudes toward science in a social context after the visit compared to the little overall change for the girls, boys` attitudes towards science were significantly lower than those of the girls during the study. In addition, teachers` personal interest in science also appeared as an important factor in fostering science learning among children.

Rennie and Williams (2006) investigated visitors` and staff`s perceptions about the communication of science in a traditional natural history museum. The research examined the science-related outcomes for adult visitors and explored visitors` and staff`s ideas of science and how it is portrayed at the museum. Data were collected by questionnaire and interviews from 84 staff and 102 visitors. Both groups held positive views about science, its importance, and the need to understand it. The comparison of visitors` pretest and posttest scores on the questionnaire revealed some significant changes, several suggesting a change to views about science that were less “scientific.” Most visitors thought that their ideas about science had not changed as a result of their visit, but they were positive about the museum as a place for learning science. Staff held more “scientific” views about the nature of science than visitors did; they recognized the potential of the museum to educate people about science, but felt it needed to be presented as more relevant and accessible, particularly in terms of science as a cultural practice.

In Türkiye, Bozdoğan`s (2007) study exploring the role and importance of science and technology museums in education is one of the pioneers in the area. The research is twofold. In the first section, it examined frequency of visits to science and technology museums and problems encountered in these visits. Furthermore, bringing solutions to the encountered problems, and enhancing the use in science teaching were investigated. Within this framework, questionnaires with multiple choice and open-ended items were mailed to 17 randomly selected primary schools from those in the provincial center and districts of Ankara. 31 administrators, 50 science teachers, and 349 students from the 6^{th}, 7^{th}, and 8^{th} grades and 93 guardians participated in this study. The second part of the research was designed as a pre-post test experimental design. The effects of the visits to science and technology museums on intent on science and academic achievement of the students in two randomly selected primary schools were examined in this scope. The results revealed that the excursions to science and technology museums in Ankara were mostly carried out through schools, and the rate of families visiting museums with their children was rather low. It was seen that the tools and materials found in Feza Gürsay Science Center and in the

Energy Park, and the activities performed in these places had an important effect on developing and sustaining a significant academic achievement and interest in science subjects. It was also found that the academic achievement was not a significant predictor of the interest scores of the students for all three experimental groups.

These results corresponded with Şentürk`s (2009) study entitled "The effect of science centers on students` attitudes towards science." In his study, Şentürk investigated the effect of METU Science Center (METU SC) on students` attitudes towards science. The sample (N=251) consisted of 131 males (52.2%) and 120 females (47.8%). An attitude scale that was developed by Kind et al. (2007) was administrated before, immediately after, and one week after a visit to METU SC. It examined the impact of METU SC on students` overall attitudes towards science with respect to their gender, grade levels, and science achievement scores. The results of the study showed that METU SC had high potential on increasing middle school students` attitudes towards science in several dimensions independent from students` gender, science achievement, and grade levels.

2.4. Summary

In this chapter, the relevant literature regarding the studies on science education, science communication, and science information sources were reviewed. The review was based on the research carried out both in national and international contexts although there was limited research in number and scope in Türkiye.

The chapter started with the relevant theories guiding this study. In this context, situated learning theory as a science education theory and uses and gratifications theory from science communication were briefly introduced. Subsequently, differences and similarities between the two disciplines were discussed through their aims, audiences, grounds, participants, assessment techniques, learning processes, outcomes, sources, and frames. Here, the aim was to show that these two disciplines had common features to be based on the bridging idea. Furthermore, while exploring new ways to improve disciplinary communication between science education and science communication, the researcher aimed to offer new perspectives to build better communication and education efforts, and to foster science learning. Yet, in both national and international content, there was limited research including science education and science communication elements simultaneously except for the study of Perera (2009). In his study, Perera investigated the implications of science communication practices on teacher professional development, but it focused on adults.

Next, the literature with regard to some of the science information sources (SIS) like books, teachers, media sources, families, and science centers/museums were presented. All the examined studies have indicated that SIS have a significant contribution to bringing scientific knowledge to people through their gratifications. These sources might present interactive, visual, hands on – minds on, and enthusiastic learning environments in both science education and science communication. However, the literature has revealed that some of the sources are mainly attributed to science communication while the others are regarded as science education sources in certain cases. As proposed by Fenichel and Schweingruber (2010), there is an increasing interest in designing information sources that explicitly support conversation and use of scientific language. The studies discussed in this chapter have revealed that if those information sources are used properly, they may increase the effectiveness of science activities, which is a common concentrate for science education and science communication.

CHAPTER III

METHOD

This chapter provides the methods and procedures used throughout the study. It starts with the overall research design. In this part, the logic of the method used in the study is explained with respect to the aim of the study. Then, it continues with the presentation of the data sources, data collection instruments, data collection procedures, data analysis procedures, and trustworthiness issues. The chapter ends with the limitations of the study.

3.1. Overall Design of the Study

The purpose of this study was to examine the meaningful sources the 4th and 5th grade students employed in learning science, their use of these sources through "what" and "how" processes and the effective and ineffective features of these sources that led to a better science learning process. Based on the science information sources, the study also investigated the integration of science communication to science education through their prominent sources. Design of the study was illustrated in Figure 3.1.

Taking the preceding aims into consideration, in-depth interviewing was used in order to investigate the experiences and perceptions of the individuals. Thus, qualitative inquiry was used in the study. Qualitative studies investigate the holistic impression of relationships, activities, situations, or materials (Fraenkel & Wallen, 2006), in order to get an in-depth understanding of the context while interpreting the events and phenomenon in terms of the meanings associated with these processes (Denzin & Lincoln, 2005; Yıldırım & Şimşek, 2008). In other words, qualitative methodologies refer to research procedures describing data through people`s own written or spoken words and observable behaviours (Bogdan & Taylor, 1975).

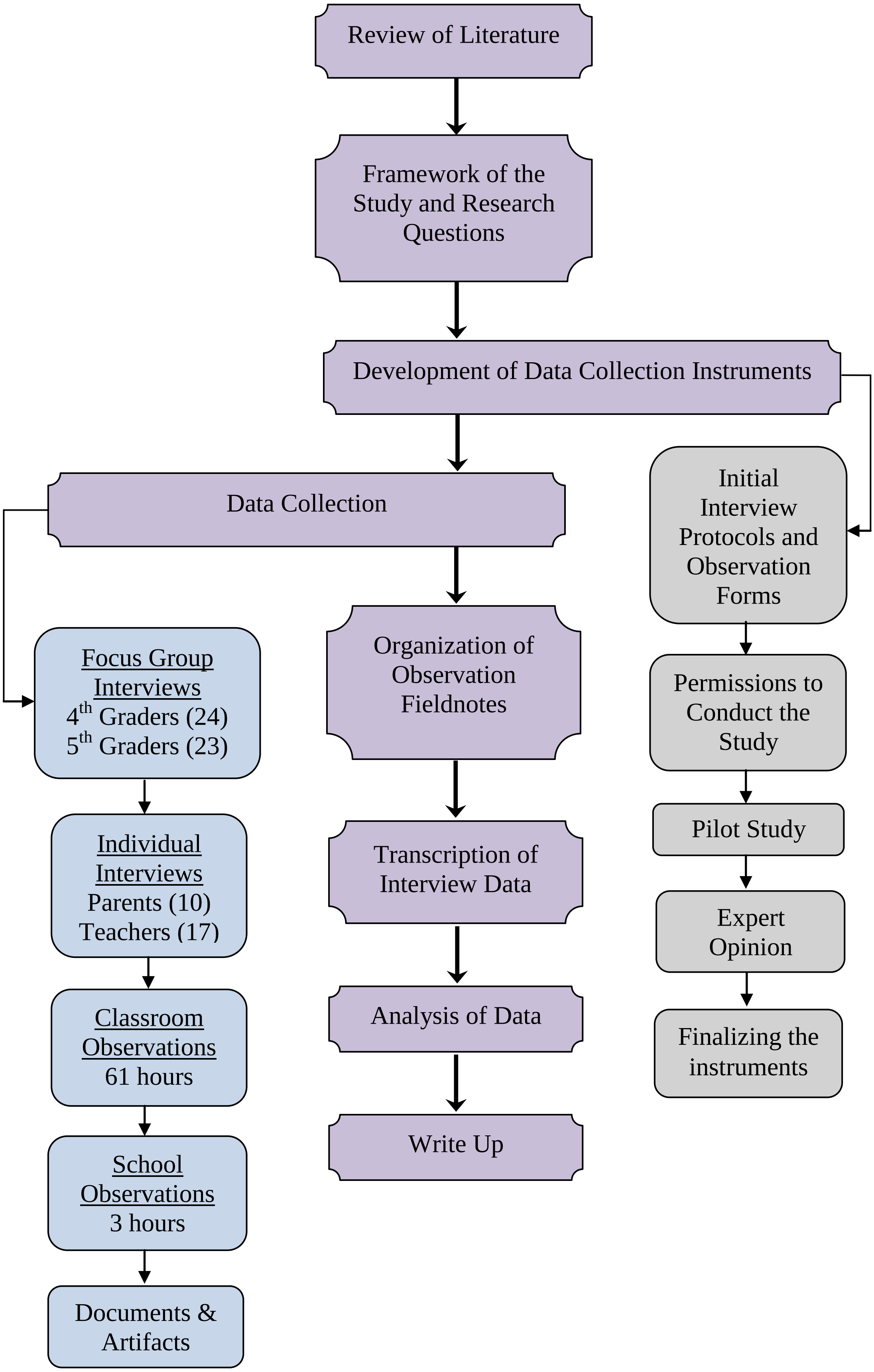

Figure 3.1. Design of the study

There were some reasons to employ a qualitative approach in the current study. In the first place, the nature of the research questions were appropriate to the nature of the qualitative study. Secondly, there was a need to gather an in-depth and detailed view of the meaningful science information sources and processes in students` learning science which could be achieved through the utilization of a qualitative approach to the study. Finally, the researcher had sufficient time and resources to spend on extensive data collection in the field and to conduct detailed data analysis of text information which was thought to increase the trustworthiness of the findings.

According to Mason (1996, p.6), "all qualitative research should be formulated around an intellectual puzzle." In defining this puzzle, Creswell (2007) discusses "what makes a good qualitative study?" and presents a list of characteristics for good qualitative studies: (1) Beginning with a single focus, (2) using an approach to qualitative inquiry and framing the study within this approach, (3) rigorous data collection and analysis, (4) reflection on the researcher`s own history, (5) thick descriptions throughout the study also in a way to engage the readers, (6) and considering ethical issues. With regard to these aforementioned characteristics, the phenomenon under inquiry in this study was students` science learning by means of various Science Information Sources (SIS). In line with this, phenomenological approach was employed in the study and various data collection instruments were adopted respectively with an emphasis to complement interview findings parallel with the nature of phenomenological inquiry.

3.1.1. Phenomenological Approach

Utilizing a phenomenological methodology, this study aims to explicit the meaning of "what" the participants lived and "how" they lived from the views of several individuals as stated by Creswell (2007) and Moustakas (1994). Two major theoretical perspectives have dominated the social science scene; one is positivism, the other is phenomenology (Bogdan & Taylor, 1975). Rooted in philosopy and phychology, phenomenology explores structure and essence of experiences of a phenomenon for a group of people (Denzin & Lincoln, 1994;

Patton, 1990; Welman & Kruger, 1999; Yıldırım & Şimşek, 2008). For Patton (1990), there is no objective or seperate reality but only personal reality. Therefore, "phenomenologist is concerned with understanding human behavior from the actor`s own frame of reference" (Bogdan & Taylor, 1975, p.2). Explaining researcher`s role in a phenomenological study, Moustakas (1994) stated that:

> The researcher following a transcendental phenomenological approach engaged in disciplined and systematic efforts to set aside prejudgments regarding the phenomenon being investigated (known as Epoche process) in order to launch the study as far as possible free of preconceptions, beliefs, and knowledge of the phenomenon from prior experience and professional studies- to be completely open, receptive, and naïve in listening to and hearing research participants describe their experience of the phenomenon being investigated. (p.22)

Accordingly, central concern in phenomenology is to record all descriptions of the social action from views of the actors (LeCompte, Millroy &, Preissle, 1992). The phenomenon here might be regarded as experiences, perceptions, conceptions and emotions that people are familiar with but whose meanings are not known (Yıldırım & Şimşek, 2008). Correspondingly, the phenomenon in this study was children`s use of different sources to learn science. This methodology enabled the researcher to find out the sources students used in learning science as well as the effective uses and features of these sources. In order to grasp a whole picture of the phenomenon of learning science through science learning sources, researcher used mixed genre data sources (students, parents, and teachers), data collection methods (interviews, observations, and document analysis), multiple theories (situated learning theory, uses and gratifications theory), and multiple investigators (supervisors of the researcher) to validate the findings.

3.2. Data Sources

"In qualitative inquiry, the intent is not to generalize to a population, but to develop an in-depth exploration of a central phenomenon" (Creswell, 2012, p.206). At this point, there exist different strategies for selecting the sample serving for thorough exploration of the phenomenon and specific research problem or questions (Miles & Huberman, 1994; Patton, 1990). Sampling strategy in this study involved two-phases. In the first phase, two public and two private schools were selected in Ankara, Türkiye. Nearby schools from the same district (Çankaya, a central district of Ankara) were chosen to have more quality time in the field (Marshall, 1996) to conduct class observations synchronically.

In the second phase, the participants were selected purposefully based on their intense experience with the researched phenomenon. Creswell (1997) and Kruger (1988) recommend this approach in sampling in a more detailed and in-depth way in order to learn or understand the central phenomenon (Creswell, 2012). Hycner (1999) says: "the phenomenon dictates the method (not vice-versa) including even the type of participants" (p. 156). Patton (1990) states that "in purposeful sampling the researcher selects participants intentionally in order to reach "information-rich" individuals and sites" (p.169). Parallel with this idea, six students from each of the 4^{th} and 5^{th} grades (total 47 students), 10 parents (two female and four male), and 17 teachers (two female and 15 male) were included in the study.

As a rule of thumb in determining the sample size, there seems somehow a consensus among researchers. The sample size in the majority of qualitative studies generally follows the concept of *saturation* (Glaser & Strauss, 1967; Boyd, 2001; Guest, Bunce, & Johnson, 2006). In phenomenological research, "the important point is to describe the meaning of a small number of individuals who have experienced the phenomenon" (Creswell, 1997, p.122). With this in mind, a sample size of 74 (47 students, 10 parents, and 17 teachers) was considered to be a reasonable number in describing the science learning experiences through various sources in detail. The main characteristics of the participants were presented further in the following parts along with the sampling strategies applied for different participants.

3.2.1. Characteristics of Student Participants

In selecting the research participants, multiple criteria were utilized. Creswell (1997) asserts that criterion sampling "works well" for a phenomenological study (p.118). Considering the concept and nature of the study, the criteria for selecting students were identified as: (1) being a 4th or 5th grader and (2) having an interest in science. Accordingly, in the study, students` age range was from 10 to 12. 23 students from 5th grades, (14 female, nine male) and 24 students (12 female, 12 male) from the 4th grades participated in the study through being involved in the focus group interviews. All students had internet access at home and school. However, private school students were found to be more advantageous in internet access since they had more opportunities to use computers in school. What is more, there was no room for science laboratories in public schools while private school students reported using science laboratories periodically as part of their science classes.

In Türkiye, the Science and Technology Curricula revolved around the same learning areas with increasing depth and scope (Living Organisms and Life, Matter and Change, Physical Events, Earth and Universe) through the 4th and 8th grades as spiral curriculum was adapted to develop the curricula. Therefore the 4th and 5th grade students are in the critical phase of learning science which could be regarded as the "first meeting years" with science. Actually, another reason for selecting the 4th and 5th grade students for the study was that, their relative position to national high stakes exams like "SBS." These students appeared somehow far away from exam anxiety compared to their upper grades. Table 3.1 illustrates the demographic profiles of student participants.

Table 3.1.

Demographic Profiles of the Student Participants

	Gender	Age	School Type	Level	Science Grade (Last Term)	Mother Education	Father Education
S1	F	10	Public	4	5	Undergraduate	Graduate
S2	M	11	Public	4	5	Undergraduate	Undergraduate
S3	M	10	Public	4	5	Undergraduate	Undergraduate
S4	M	10	Public	4	5	Undergraduate	High School
S5	F	10	Public	4	5	Undergraduate	Graduate
S6	M	11	Public	4	5	Undergraduate	Undergraduate
S7	F	10	Public	4	5	High School	Undergraduate
S8	F	10	Public	4	5	High School	Undergraduate
S9	F	11	Public	4	5	Undergraduate	Undergraduate
S10	F	10	Public	4	5	Undergraduate	Undergraduate
S11	M	10	Public	4	5	Undergraduate	Undergraduate
S12	M	10	Public	4	5	High School	High School
S13	M	10	Private	4	5	Undergraduate	Undergraduate
S14	F	10	Private	4	5	Undergraduate	Graduate
S15	F	11	Private	4	5	Undergraduate	Graduate
S16	F	10	Private	4	5	Graduate	Undergraduate
S17	F	11	Private	4	5	Undergraduate	Undergraduate
S18	F	10	Private	4	5	Undergraduate	Graduate
S19	M	10	Private	4	5	Undergraduate	Graduate
S20	M	10	Private	4	5	Undergraduate	Undergraduate
S21	M	10	Private	4	5	Undergraduate	Undergraduate
S22	F	10	Private	4	5	Graduate	Graduate
S23	M	10	Private	4	5	Undergraduate	Undergraduate
S24	M	10	Private	4	5	Undergraduate	Undergraduate

Table 3.1. (continued)

Demographic Profiles of the Student Participants

	Gender	Age	School Type	Level	Science Grade (Last Term)	Mother Education	Father Education
S25	F	11	Public	5	5	Undergraduate	Undergraduate
S26	F	12	Public	5	5	Undergraduate	Undergraduate
S27	M	10	Public	5	5	Undergraduate	Undergraduate
S28	F	11	Public	5	5	Undergraduate	Graduate
S29	M	11	Public	5	5	High school	Undergraduate
S30	M	12	Public	5	5	Undergraduate	Undergraduate
S31	F	11	Public	5	5	Undergraduate	Undergraduate
S32	F	11	Public	5	5	Graduate	Graduate
S33	F	11	Public	5	5	Graduate	Undergraduate
S34	F	11	Public	5	5	Undergraduate	Undergraduate
S35	F	11	Public	5	5	High school	High school
S36	F	11	Public	5	5	Undergraduate	Graduate
S37	F	11	Private	5	5	Graduate	Graduate
S38	F	12	Private	5	5	Undergraduate	Graduate
S39	F	11	Private	5	5	Graduate	Graduate
S40	M	11	Private	5	5	Undergraduate	Undergraduate
S41	M	11	Private	5	5	High school	High school
S42	M	11	Private	5	5	Undergraduate	Graduate
S43	F	10	Private	5	5	Undergraduate	Undergraduate
S44	M	11	Private	5	5	Undergraduate	Undergraduate
S45	M	11	Private	5	5	Undergraduate	Graduate
S46	F	11	Private	5	5	Undergraduate	Undergraduate
S47	M	11	Private	5	5	Undergraduate	Graduate

3.2.2. Characteristics of Parent Participants

Parents were selected among those whose child was studying at the 4th or 5th grades in the 2010-2011 Spring Term. All of the 4th and 5th grade parents in four schools were distributed an information letter including information about the study. In this form, parents were informed with regard to the research activity, procedures, and their potential contributions. Moreover, at the end of the form, parents were kindly asked for their agreement to participate in the study through interviews about their children`s use of science information sources. Among the 15 parents signing the form, 10 parents who wrote their communication information were selected. Parents did not match the interviewee students however they served as information rich cases in terms of providing the researcher to gather an in-depth understanding of the science learning process of the students. Table 3.2 illustrates demographic information for participating parents.

Table 3.2.

Demographic Profiles of Parent Participants

	Gender	Age	Child`s School Type	Educational Background	Job	Monthy Income
P1	M	39	Public	Undergraduate	Trade	₺ 3000 and over
P2	F	44	Public	Undergraduate	Teacher	₺ 3000 and over
P3	F	35	Public	Undergraduate	Housewife	₺ 1000 -3000
P4	F	44	Public	Undergraduate	Inspektor	₺ 3000 and over
P5	F	38	Public	High school	Housewife	₺ 1000 -3000
P6	M	50	Public	Graduate	Doctor	₺ 3000 and over
P7	M	43	Public	Undergraduate	Civil cervant	₺ 3000 and over
P8	F	38	Private	Graduate	Academician	₺ 3000 and over
P9	F	45	Private	Undergraduate	Civil cervant	₺ 3000 and over
P10	M	44	Public	Undergraduate	Teacher	₺ 3000 and over

Parents` age ranged between 35 and 50, and most of the parents had a college degree and a full-time job. Families` monthly income levels showed slight variations, ranging from 1000-3000 to 3000 over.

3.2.3. Characteristics of Teacher Participants

All volunteer 4th and 5th grade class teachers in the public schools who volunteered to participate in the study constituted the teacher participants of the study.

Table 3.3.

Demographic Profiles of the Teacher Participants

	Age	Gender	School Type	Grade	Teaching Field	Educational Background	Year of Experience
T1	47	F	Public	4	Classroom Teacher	Classroom Teaching	23
T2	43	F	Public	4	Classroom Teacher	Economy	20
T3	55	F	Public	5	Classroom Teacher	Classroom Teaching	35
T4	50	F	Public	5	Classroom Teacher	Classroom Teaching	31
T5	42	F	Public	5	Classroom Teacher	Graduate – Child Development	14
T6	49	F	Public	4	Classroom Teacher	Classroom Teaching	28
T7	43	F	Public	4	Classroom Teacher	Classroom Teaching	18
T8	46	M	Public	5	Classroom Teacher	Philosophy	19
T9	55	M	Public	4	Classroom Teacher	Economy	32
T10	53	F	Public	5	Classroom Teacher	Economy	30
T11	38	F	Private	4 – 5	Science Teacher	Biology	15
T12	30	F	Private	4 – 5	Science Teacher	Science Education	8
T13	29	F	Private	4 – 5	Science Teacher	Science Education	7
T14	33	F	Private	4	Classroom Teacher	Classroom Teaching	12
T15	32	F	Private	5	Classroom Teacher	Classroom Teaching	11
T16	30	F	Private	4 – 5	Science Teacher	Biology Education	2
T17	37	F	Private	4 – 5	Science Teacher	Science Education	14

As different from the public schools, science and technology teachers were teaching science courses in the private schools. Thus, in private schools, science and technology teachers constituted the teacher participants of the study.

As displayed in Table 3.3, teachers` age range varied from 29 to 55. Age interval among private school teachers (29-38) were lower than that of the public school teachers (38-55). The teachers differed in the experience in the field. Their teaching experience ranged between two and 35 years. As for the educational background, except four teachers, all of the teachers had education related degree. Most of the teachers were female because there were not many male teachers teaching at the 4th and 5th grades as seen in the Table 3.3.

3.3. Data Collection Instruments

In line with the nature of the phenomenological inquiry, interview was used as the primary data collection instruments for the study (Yıldırım & Şimşek, 2008). Additionally, the study was supported with the observations to provide "first hand information by observing people and places at the site" (Creswell, 2012, p.213) and documents to obtain further information about the site (Creswell, 2012).

The details of the data collection instruments namely, interviews protocols (for students, parents, and teachers), classroom and school observation forms, and documents and artifacts that were used in the study were described in detail next.

3.3.1. Interview Protocols

In order to enhance flexibility in probing (Patton, 1990) "different types of interviews can be employed at different stages" (Bogdan & Biklen, 2007, p.104). Explaining what they meant by "different stages" authors stated that:

> Some people debate which approach is more effective, the structures or the unstructured. With semi-structured interviews you are confident of getting comparable data accross subjects, but you lose the opportunity to understand how the subjects themselves structure the topic at hand. (...) You choose a particular type based on your research goal. (...) At the beginning of a project, for example, it might be important to use the more flee-flowing, exploratory interview because your purpose at that point is to get a general understanding of a range of perspectives on a topic. After the investigatory work has been done, you may want to structure the

> interviews more in order to get comparable data accross a larger sample or to focus on particular topics that emerged during the preliminary interviews. (p.104)

Accordingly, interview protocols for students (focus group interview), parents (individual interview), and teachers (individual interview) were developed based on the literature and research questions with structured and semi-structured questions and probings. All the protocols were submitted to the experts for review in terms of the depth, scope, appropriateness to the different participants, and compatibility with the research questions. The interview questions were checked by three individuals: Researcher`s advisor, who is a professor in Curriculum and Instruction, and two colleagues, one of whom completed her Ph.D. and the other is a Ph.D. candidate in the same department with the researcher. Considering the feedbacks in context of expert opinion, the instruments were revised and refined. Upon the obtainment of the permissions to conduct the study, the interviews were piloted and finalized accordingly.

Interviews started with small talks (Bogdan & Biklen, 2007) to initiate and proceed a comfortable conversation with the participants. Afterwards, the researcher informed the interviewees about the purpose of the interview, description of the study, confidentiality, valuntary nature of participation, and the lenght of the interview. In order to capture the process accurately (Bogdan & Biklen, 2007) the researcher used tape-recording. After getting permission about the recording, interviewees` questions were responded if they had any. Following this step, the interviews were initiated.

The main purpose of the interview was to define the sources the 4th and 5th grade students used in learning science, their usage of these sources through "what" and "how" processes and the features of these sources from students`, parents` and teachers` views. Based on science information sources, the study also aimed to connect science education to science communication through the sources which became one of the foci of the interviews as well.

3.3.1.1. Interview Protocol for Students

Student participants were interviewed within six-student focus groups. The 4th and 5th graders` interview protocols were identical. In the student interview protocol, there were 12 main questions with sub-questions (see Appendix A for the English and Turkish versions of the students interview form respectively). Interview questions were initiated with demographic questions (age, grade in science and technology class, usage of some sources in general), and continued with the main interview questions. The first two questions (questions about the defitinion of science, the features of scientific knowledge, drawing science, and the question about students` science interest) were broader ones in order to understand students` perceptions about science with an introductive meaning. Question three had also a leading nature regarding the science information sources with its sub-questions like "Are you conducting research on this subject, which sources are you using?, and how do you benefit from these sources?". The next question starting with "Think about a typical science class" was mainly about classroom dynamics with an aim to understand which sources were being used in typical science classes, and understandable and interesting science information sources from the students` point of view. Question 5 was about the frequencies in using science information sources while the question 6 was about learning students` favourite sources in learning science. The following question, asked about sources that provided permanent science knowledge in students: "Which science subjects you remember from the last year? with its sub-questions: "Where did you learn them from?" and "What do you think about the reasons make you remember?". With a focus of making it explicit, the use and features of science information sources with a science education and science education perspective researcher mainly departed from students` experiences or imagination with assumption questions like "In the future would you prefer to have a job related to science and technology?, Which experiences directed you to think like that?", or "Suppose that you discovered remarkable things in your field of study. Do you want to share your findings with people to inform them? How? Which sources would you prefer?" in the questions of 8, 9, 10, and 11. The final question, emerging as the second metaphor question of the study, ended the interview with students` perceptions and drawings on "science communication." Table 3.4 displays student, teacher and parent interview questions with the related themes, and research questions.

Table 3.4.

Matching Interview Questions with Themes, and Research Questions

Research Questions	Themes	Interview Protocols	Interview Questions
RQ 1	SIS	SIP	IQ1, IQ3, IQ4, IQ5
		TIP	IQ1
		PIT	IQ2, IQ6
RQ 2	Uses of SIS	SIP	IQ3, IQ4, IQ5, IQ6, IQ8, IQ9
		TIP	IQ2, IQ5, IQ8
		PIT	IQ2
RQ 3	Effective and Ineffective Features and Uses	SIP	IQ3, IQ4, IQ5, IQ7, IQ8, IQ10, IQ11
		TIP	IQ1, IQ2, IQ4
		PIT	IQ1, IQ2, IQ3, IQ6

Note. Abbreviations: SIS: Science Information Sources, SIP: Student Interview Protocol, TIP: Teacher Interview Protocol, PIT: Parent Interview Protocol, IQ: Interview Question

3.3.1.2. Interview Protocols for Teachers and Parents

Teacher and parent interviews were carried out in order to enrich and complement the data gathered through student interviews both in-class and out-of-class contexts (see Appendix B and C for the English and Turkish versions of the teacher and parent interview forms respectively). Teachers and parents were mainly asked about the sources that children use in learning science and their perceptions on the features of science information sources in children's learning science. The themes covered in questions were similar to the themes asked to students.

In parents` interview protocol, there were eight questions. In addition to the ones in student interview forms, parents were asked about whether they did special activities in increasing children`s science interest, and additional science information sources that they found meaningful in their child`s science learning.

There were nine questions in teachers` interview protocol. As different from the students` interview protocols, teachers were asked about the sources they used in planning science curriculum and instruction, their perceptions on the current science curriculum and additional science information sources that they believed to be meaningful in their students` science learning.

3.3.2. Observation

The researcher, acting as a participant observer, did observations in regular science classes of students without interfering or disrupting their natural classroom settings. Bogdan and Taylor (1975) discussed that the researcher is mainly between active participant and passive observer in a qualitative study. Moreover, Patton (1990) explains the role of the researcher in qualitative research as “The researcher is the instrument" (p.14). In a similar vein, from the viewpoint of Creswell (1997, p.18) researcher`s role as an active learner was emphasized with characterizing him or her as a person “who can tell the story from participants” view rather than a person “who passes judgment on participants.”

Observation guide was developed by the researcher considering the research questions, and finalized through the revisions of researcher`s advisor and a colleague. The following specific questions provided the guideline for observation:

(1) What kind of science information sources are used during the science classes?

(2) How do students use these science information sources in learning science?

Throughout the observations, the researcher used paper, pencil, and a watch while recording what happened in the lesson based on the questions given. Running account technique was used in order to note down the process in a more practical way. The duration of the observation for each science course was about 40 minutes.

3.3.2. Documents and Artifacts

Documents are "valuable source of information" in qualitative research (Creswell, 2012, p.223). Documents and artifacts used in the study were textbooks, student workbooks, teachers` books, handouts, students` notebooks, students` science projects, educational software (Morpa Kampüs, Ttnet Vitamin), science magazines (Bilim Çocuk, National Geographic Kids), and popular TV programs that students stated using in learning science. As a remarkable point here, schools were all using the same textbooks, except one private school which was using a different one for the 4th grade classes. The flow of the units in this textbook was exactly the same with the other textbooks used, with enriched activities but limited content presentation.

3.4. Data Collection Procedures

This section covers how the data were collected for this study focusing on the development of data collection instruments, permissions and consents taken to conduct the study and pilot phase of study). It ends with a detailed schedule showing overall schedule for the dissertation work. The procedures applied during the data collection procedure were described in Table 3.5.

3.4.1. Permissions and Consents

In order to get permissions to initiate the study, the researcher initially applied for the Applied Ethics Research Center (UEAM) at the Middle East Technical University (METU) in March 2011. Accordingly, an application form, a project information form and a parent approval form were submitted with the copy of interview and observation forms to the UEAM for the approval of Human Subject Ethics Committee. Subsequently, after receiving an approval from the UEAM (see Appendix E) in April 2011, the researcher applied the MoNE with a list of the name of the schools where she was planning to conduct the study. After completing the required consents from the MoNE (see Appendix F), the researcher visited schools and introduced herself to school administrators and teachers to inform them about the nature of the research and researcher`s role in the classrooms and kindly asked for their voluntary involvement in the study.

Table 3.5.

Time Schedule for the Study

DURATION / TASK	Nov-Dec \`10	Jan-Feb \`11	Mar-Apr \`11	May-July \`11	Aug-Dec \`11	Jan-May \`12	May-Nov \`12
Review of literature							
Development of data collection instruments							
Applying to METU ethics and MoNE consent							
Piloting the instruments							
Finalizing the instruments							
Data collection (1) Interviews with -4th and 5th graders (focus) -Parents (individual) -Science and technology teachers (individual)							
(2) Observations							
Research in U.S.A.							
Data transcribing							
Data analysis							
Write up							
Completion							

The observations started with public schools as the researcher had to follow some extra procedures in private schools in addition to UEAM and MoNE approvals. As one of the private schools\` administration approved just one classroom observation, the school was eliminated from the study. Although another private school approved the study, their science theme passed at the time of the study. Therefore, class observations could not be conducted in this school which will be discussed further within the limitations of the study.

3.4.2. Pilot/ Initial Interviews

Individual interviews were conducted with the students, parents, and teachers before the actual interviews. The interview protocols were piloted with two 5th grade students, one 4th grade student, two parents, and a teacher in April 2011. Interview protocols were finalized in light of the pilot study and organized in a way to deepen the data collection. By doing this, the questions, prompts, and probes were arranged, the wordings of the questions were revised, and the weaknesses and strengths of the questions were determined in order to gather in-depth data via the tools. To illustrate, in the initial protocol, radios were among the sources of science information while classmates and educational software were not. Through pilot study with students, teachers and parents, radios as science information sources were decided to be removed from the protocol as students were not using them anymore. In addition to this, classmates and educational software were included among the science information sources in light of the piloting process.

3.4.3. Conducting the Interviews

Students were interviewed in focus groups as well. “Focus groups produce large amounts of concentrated data in a short period of time” (Morgan, 1998, p.32). For focus groups typically five to ten people are selected because they have something in common (Krueger & Casey, 2000). In this study, for focus groups, students were purposefully selected from the students who had an interest in science with the collaboration of the teachers and school administration. However, in Private School A, school administration directed the researcher to the students who had a science interest. That is why, some students in the interview mentioned that they were not interested in science as different from the other interviewees but they still voluntarily participated into the focus group to share their experiences.

Regarding frequency and length of the interviews, Bogdan and Tylor (1975) asserted that:

> ...interviews should be long enough to adequately cover the topics that are raised but not so long that either you or the subject is fatigued. In general, it takes some time to get started , to get the dialog to center on important topics. Once you are on a certain topic, such as high school, let your subject talk her-or himself out. You should, therefore, allocate rather large periods of time for each interview. Anything less than one hour is too short. You need at leart two hours or more to explore any topic in depth. And anything longer than about four hours will probably burn the subject out. (p.109)

Considering Bogdan and Tylor`s views, interviews lasted approximately two hours including a ten-minute break. In the 5th grades one of the interviewee students in a private school could not participate the interview session because of her health problems. Including six students from the 4th and 5th grades from each school, researcher interviewed with 47 students in total. Students were interviewed in six-student-focus groups during the school day in a convenient place shown by school. Explaining the group size in focus groups Krueger and Casey (2000) assert that:

> The group must be small enough for everyone to have an opportunity to share insights and yet large enough to provide diversity of perceptions. (p.10)

10 parents participated into the study. Parents were interviewed in convenient places they suggested. Three parents were interviewed via phone-call because of the inconvenience to arrange a face-to-face meeting. Parent interviews lasted about thirty minutes.

As for the teachers, 17 teachers were interviewed during the school day in their available time intervals. Interviews lasted approximately 40 minutes with two exceptions which lasted about 60 minutes.

3.4.4. Pilot/Initial Observation

In order to get familiar with the setting, visit the scene and to have an idea of the context being studied in relation to the official data collection process, the initial four hours of the classroom observations (three hours in two different classes in Public School A, and one hour in Public School B) served as the pilot observations before the actual observations.

3.4.5. Conducting the Observations

The observations started with the public schools on May 6, 2011 and private schools joined the study when all the permissions finalized on May 30, 2011. Observations continued until June 14, 2011. The purpose of the classroom observations was to capture the class atmosphere, to obtain data on the 4th and 5th grade students` use of the science information sources, and their interaction with in-class SIS (textbooks, other scientific books, teacher, peers, etc.) in science courses (see Appendix D).

With an aim to conduct synchronized observations in science classes in four different schools at the same time, the researcher developed a detailed schedule illustrating the time intervals, schools and daily classes, during the observation period. In total, 64-hour observation was conducted including 61 hours classroom and three hours school observations (Students` Science Fair in Private School A). Observations were conducted in 22 different branches in the 4th and 5th grade classrooms; and it covered 33 hours in the 4th grade classes whereas it was 28 hours in the 5th grade classes. Moreover, the researcher observed all different branches in three schools (Public School A-B, Private School B), and interviewed with 14 teachers out of 17, and 36 students out of 47. Table 3.6 represents the hour basis observation summary.

Table 3.6.

Total Amount of Times for Observations by Grade Level

Grades	In-class observation	Out-of-class observation
4th grade	33 hours	3 hours (Science Fair for 4th and 5th graders in Private School)
5th grade	28 hours	

Note. Total hour observations: 64 hours

As mentioned earlier in the chapter, the researcher could not have any chance to conduct observations in Private School B since their science theme passed when the actual classroom observations took place. Accordingly, the researcher watched a couple of recorded science course sessions lasting 120` from the science lab teachers` archive and took some observational notes through those records to increase the trustworthiness of the study.

3.5.Data Analysis Procedures

There are many different approaches in qualitative data analysis process (Miles & Huberman, 1994). In a qualitative study, data analysis is an attempt to respond to the research questions through exploring the patterns and themes filtered from observations, documents and interviewees expressions.

As stated by Miles and Huberman (1994), qualitative data analysis is a continuous process with data collection, data display, data reduction, and conclusions. In doing this, data collection and data analysis parts of the study go hand in hand and the intersections between these processes guide the study as illustrated by Figure 3.2.

Specifically, "phenomenologists often work with the interview transcriptions in order to capture the essence of the account" (Miles & Huberman, 1994, p.8). "The informant`s statement represents merely the perception of the informant, filtered and modified by his cognitive and emotional reactions and reported through his personal verbal usages" (Dean & Whyte; as cited in Bogdan & Tylor, 1975). In analyzing the interviews, the main focus was bracketting these verbal usages.

Researchers` own theoretical and philosophical stances, their analysis process in a qualitative study. Good research requires making these stance and approaches explicit in the writing of the study (Creswell, 2007). Taking this into account, researcher presented a vivid description of the data analysis process in detail to make it explicit for the readers.

3.5.1. Arranging Data for the Analysis

All recorded 74 interviews were transcribed word by word between September 2011 and December 2011 by the researcher. To facilitate coding and note taking process, the researcher used formatted Microsoft Word documents. In the transcription of the focus group interviews, she used pseudonyms for each of the student respondents in order to seperate six respondents in groups. Upon the completion of this step, the transcriptions were revised again with the original voice records to check the missing points or to include the changes in interviewees` emotion or expression to the transcripts.

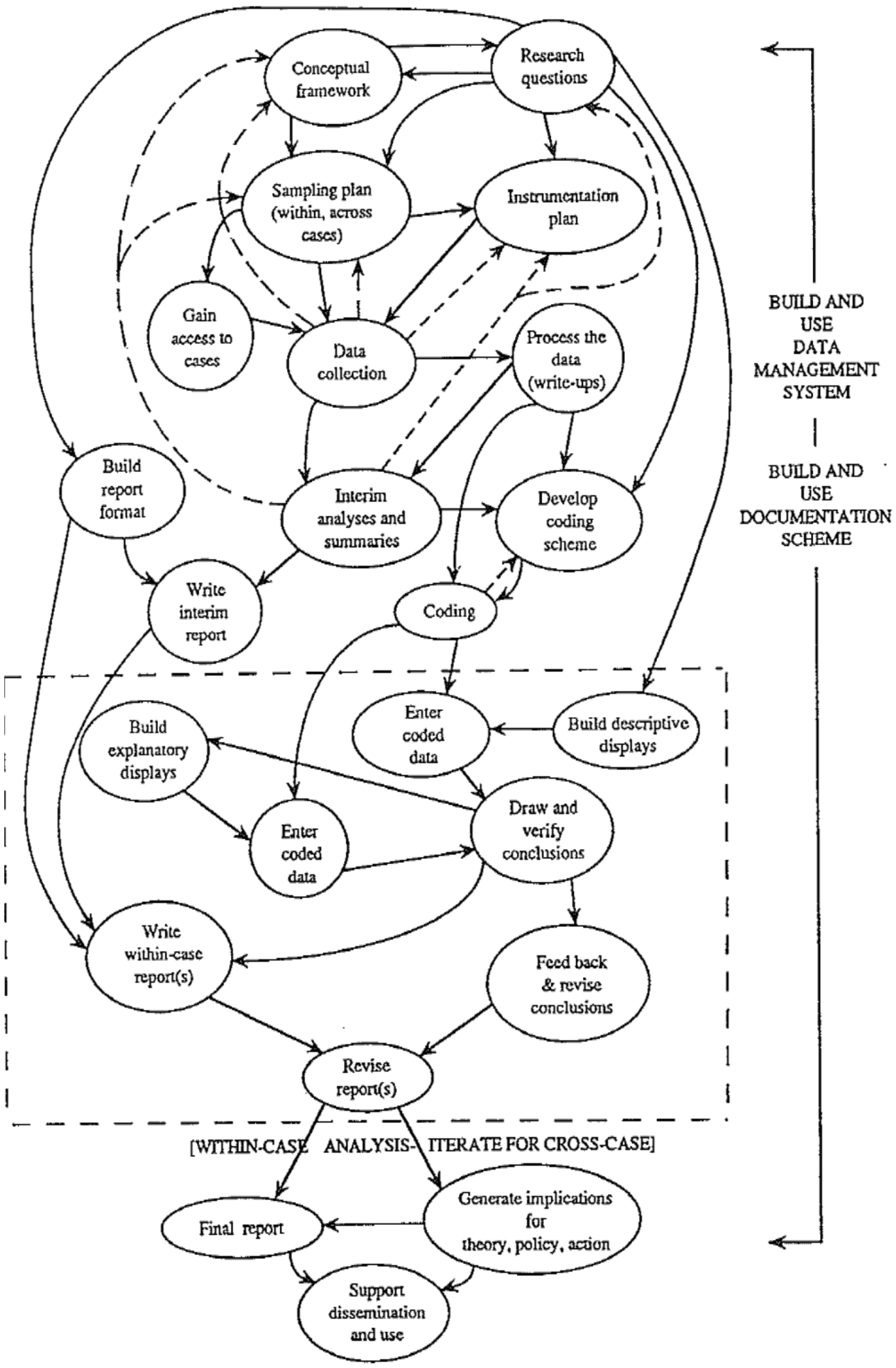

Figure 3.2. Overview of qualitative data analysis processes. Reprinted from Qualitative data analysis: An expanded sourcebook (2nd Edition) (p. 308), by M.B. Miles & A.M. Huberman, 1994, Newbury Park, CA: Sage Publications. Copyright 1994 by the Sage Publications. Reprinted with permission.

First of all the transcriptions were filed separately for schools, grades, and participants (students, teachers, parents) respectively. Codes were assigned to participants (students: S; parents: P; teachers: T) with numbers (S1: student 1; P1: parent 1; T1: teacher 1). For schools, Public Schools A, B and Private School A, B expressions were used instead of the original names of these schools. Observation fieldnotes were organized and compiled into a file taking the complementary nature of the documents and observations into account prior to the data analysis process. Afterwards, all 4th graders and 5th graders` focus group interview transcriptions were combined into Microsoft Excel documents, separately. Following this, the same process was applied for teachers and parents, as well.

The researcher carried out the qualitative data analysis both by hand and then by computer with qualitative data analysis software: MAXQDA 10 (also called as QDA software) which is a powerful tool for both qualitative and quantitative applications (Creswell, 2012). Weitzman (2003) asserts that using a software in the analysis of the exhaustive qualitative data is now getting "more and more to be a regular part of the qualitative research process" (p.337). As Bogdan and Biklen (2007) emphasize:

> Computer software for qualitative data analysis enables the researcher to code easily the same segment of data in multiple ways, to compare data that have been coded differently (…). These programs also show the frequency of codes. (p.189)

The reason why the researcher conducted computer based qualitative data analysis apart from the manual analysis lied behind the nature of the qualitative data. The way of the data analysis enabled the researcher to avoid data redundancy and come up with to the point themes, sub-codes, and codes parallel with the research questions.

3.5.2. Processing Data Analysis

Notably, a phenomenological data analysis enabled the researcher to be able to choose significant statements, explain the meanings of the statements, identify the themes of meanings, and present exhaustive description of the phenomena (Creswell, 1997; Moustakas, 1994). Creswell (1997) explains how data analysis in a phenomenological study proceeds as follows:

> Phenomenological data analysis proceeds through the methodology reduction, the analysis specific statements and themes, and a search for all possible meanings. The researcher also sets aside all prejudgments, bracketing his/her experiences and relying on intuition, imagination, and universal structures to obtain a picture of the experience (p.52).

Accordingly, following steps were applied for the manual analysis that was conducted right before computer program analysis. Firstly, files for the data were created and organized (Creswell, 1997). Within this context, the data were read over and over again while taking notes in order not to overlook any single detail that may serve for the better understanding of the research questions. In the first cycle of coding process, data were labeled by descriptive codes. This enabled the researcher to eliminating the less important sections and begin to develop themes that responded to the guiding research questions. While reading through the text, the researcher made margin notes and formed initial codes (Creswell, 1997). In the second cycle of the coding as shown in the Figure 3.3, the codes and sub-codes were reviewed and revised again and necessary modifications were made to ensure that codes were evenly applied across the data. The codes and sub-codes were finalized in order to reach a more general pattern.

As the second step of the data analysis, the meaning of the experience for the researcher (Creswell, 1997) was described. Finding and listing statements of meaning for individuals; grouping statements into meaning units; developing a textural description of “what happened”; developing a structural description of “how” the phenomenon was experienced; developing an overall description of the experience, the “essence” (Creswell, 1997, p.149) were the steps guiding the data analysis process. In line with this, the lists of the initial codes were analyzed and according to the common aspects of the codes, and major categories were identified. Related codes were collected under the major categories.

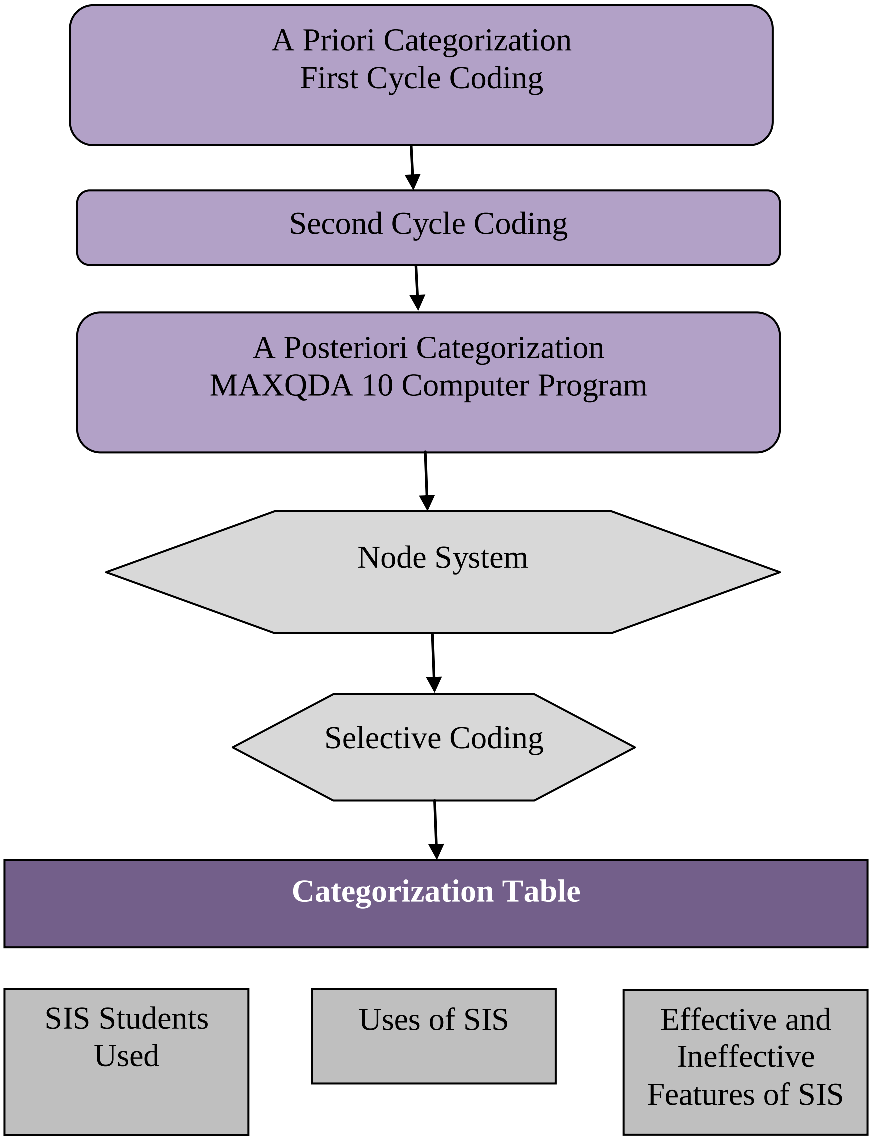

Figure 3.3. Coding process of the study.

Finally, tables or figures of statements and meaning units were used to present narration of the "essence" of the experience (Creswell, 1997, p.149) which were later converted into the emergent themes within the results chapter. In line with this, quotations were used in order to enrich the results and to provide validity.

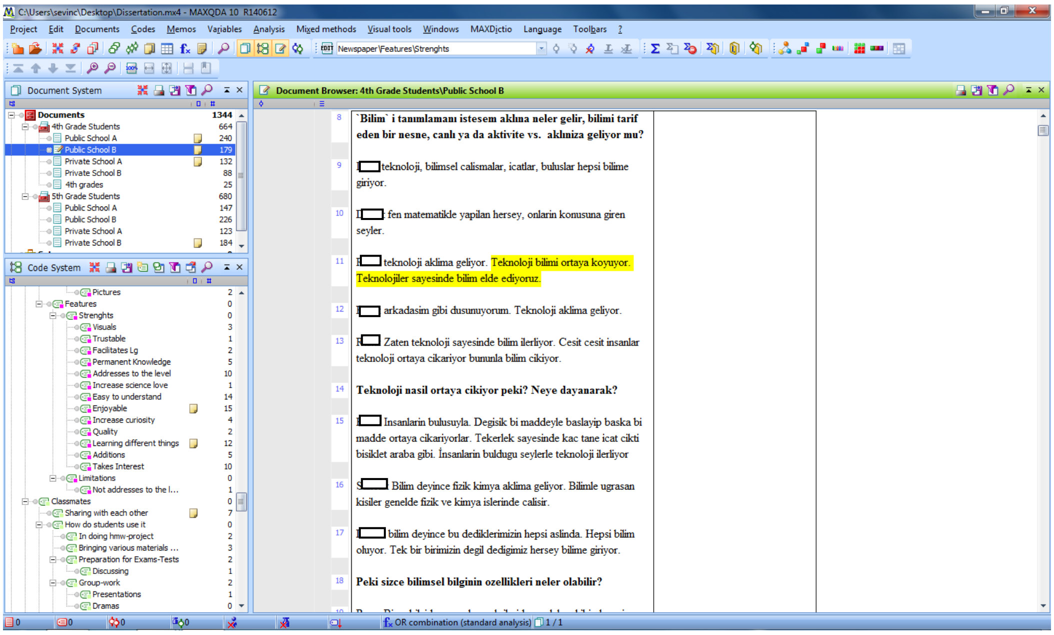

Figure 3.4. An example from the MAXQDA software analysis.

As for the analysis with MAXQDA 10 software (see Figure 3.4), all data files were arranged and uploaded to the program and the analysis was conducted document by document. Questions asked by the interviewer were moved to the left side of the documents not to analyze the questions. Then, themes were sorted as: Features of SIS, uses of SIS, and effective and ineffective features of SIS as illustrated by Figure 3.3. Themes, sub-themes and codes were colored simultaneously to see different parts of the study clearly. Next, some critical parts were highlighted to be used as quotation in reporting the results.

In document analysis part, science textbooks, student workbooks, teachers books, students, notebooks, educational software (Morpa Kampüs, Ttnet Vitamin), students science projects, science magazines (Bilim Çocuk, National Geographic Kids), and popular TV programs in relation to the research questions were analyzed parallel with the research questions. In doing this, researcher gathered the specific details (Bogdan & Biklen, 2007) to understand the phenomenon better.

3.6. Trustworthiness

In contrary to the quantitative studies, validity and reliability are viewed together in qualitative approach (Bogdan & Biklen, 2007). Mishler (2000) points out that validity and reliability were replaced by trustworthiness in qualitative research. Regardless of being a qualitative or a quantitative study, validity and reliability are the backbone of the study. These two concern with the question of "How can an inquirer persuade his or her audiences that the research findings of an inquiry are worth paying attention to?" (Lincoln & Guba, 1985, p. 290). In line with this, Seale (1999) states that "trustworthiness of a research report lies at the heart of issues conventionally discussed as validity and reliability" (p. 266). In a similar vein, Lincoln and Guba (1985) define trustworthiness as follows:

> How can an inquirer persuade his/her audiences (including self) that the findings of an inquiry are worth paying attention to, worth taking account of? What arguments can be mounted, what criteria invoked, what questions asked, that would be persuasive on this issue? (p.290)

Different procedures exist in order to check or enhance validity and reliability (Creswell, 1997; Fraenkel & Wallen, 2006; Lincoln & Guba, 1985; Patton, 1990). For Lincoln and Guba (1985) credibility (internal validity), transferability (external validity, generalizability), dependability (reliability), and confirmability (objectivity) were used to establish validity and reliability of a study. These four were conceptualized as the four legs of the research.

To begin with, credibility concerns with the question: "How congruent are the findings with reality?" (Merriam, 1998, p.213). Among the strategies discussed to establish credibility (Lincoln & Guba, 1985), triangulation, prolonged engagement, persistent observation, peer debriefing, and referential adequacy were used in the study. Firstly, multiple data sources (students, parents, and teachers), multiple data collection modes (interviews, observations, document analysis) and multiple investigators (supervisors of the researcher), and multiple theories (situated learning theory, uses and gratifications theory) were used in the study. This was explained as *triangulation* by many researchers. Patton (1990) emphasizes the use of triangulation by combining multiple sources, methods, or investigators. In addition to these three combination, Denzin (1978) presents multiple theories to triangulation. Triangulation by different methods can be implied either to different data collection modes like interviews, questionnaires, observations, or designs (Lincoln & Guba, 1985). On the other hand, some other researchers assert that this is "cyristallization", not triangulation as Richardson (2000, p.934) does: "we do not triangulate; we crystallize. We recognize that there are far more than 'three sides' from which to approach the world." Furthermore Janesick (2000, p. 392) describe *crystallization* as what we perceive when we look at a crystal and state that it "depends on how we view it, how we hold it up to the light or not."

Secondly, *prolonged engagement*, as another strategy to increase the credibility of the study was employed in the study. It refers to spending sufficient time with respondents in their natural environments to gain a better understanding of their behaviour, values, and relationships in this context (Lundy, 2008). To do this, the researcher conducted approximately 60 of observations in four schools. Although any observation could be regarded more than just spending time in a setting, classroom observations conducted within the framework of this study enabled the researcher to develop a better understanding of how the students utilized science information sources to develop science learning. Thirdly, through *persistent observation*, things that count in relation to the research questions (Lincoln & Guba, 1985) and the details of the phenomena under study were explored, which helped the researcher to establish a pattern within and between the observations.

Another strategy to enhance the credibility was formal and informal discussions while exploring the aspects of the inquiry with supervisors of the researcher. The main supervisor is a professor in Curriculum and Instruction and a well-known researcher in qualitative research area in Türkiye and co-supervisor of the researcher is one of the leading researchers in the science education area in the U.S. This provided *peer debriefing*. The researcher collected the data in Türkiye between May-July 2011. The formal discussions held with the supervisors enabled the researcher to get mots out of the data as she consulted on them while developing the data collection instruments, collecting the data and later on analysing and interpreting the data. In addition to the contributions of the supervisors, the researcher presented the draft of the study for the review of two leading professors in the field of science communication: Prof. Dr. Bruce Lewenstein and John E. Ross Professor Dietram Scheufele, and the study was revised through their recommendations, as well. Last but the not least, two meetings were arranged with the thesis committee during the process and committee members assessed the flow of the study with their feedbacks on it, which significantly contributed to the credibility of the study.

Transferability was accomplished by explaining all procedures in a detailed way through *thick descriptions* to enable someone interested in making transfer to reach a conclusion (Lincoln & Guba, 1985). This also enhanced the *replication* of the study, as well. During the interviews and observations, daily personal thoughts were also noted down in order to check and enrich the recorded data and these notes resembled the concept of *reflexive journal* offered by Lincoln and Guba (1985).

Another way to enhance the transferability of the study was to audio record all the interviews to prevent the possible data loss. The recorded materials provided a benchmark for the later analysis enhancing *referential adequacy* (Lincoln & Guba, 1985) which was also a strategy to establish credibility. Having fully transcribed all the interviews, researcher was very familiar with the data. Naturally, this facilitated the data analysis part since researcher had a comprehensive knowledge on the data. All completed transcriptions were checked again in comparison with the original voice records to revise the missing points or to reflect the changes in the interviewees` emotion or expression to the transcripts. The transcriptions were finalized using common but broad transcription conventions as the details of the turns of the talk were not critical for the research. In addition to that, in the data analysis part, MAXQDA software was used along with Miles and Huberman`s widely accepted content analysis approach.

Dependability and confirmability of this research was established through *independent audit*. As suggested by Lincoln and Guba (1985) the decision trail used through methods to conclusions of the study was followed by a competent peer (Patton, 1990). The researcher`s independent audit had recently her Ph.D. in the same department with the researcher and her experience was generally equivalent with the researcher. During the dissertation process, starting from instrument development to the reporting (Halpern, 1983) all parts were all examined and discussed with her. In addition to that, researcher had periodical meetings with her supervisor during the dissertation process. Through her studies in the U.S. between the years of 2011 and 2012, the researcher had weekly meetings with her co-supervisor, as well. All abovementioned procedures configured the study.

3.7. Limitations of the Study

Doing a qualitative study, researcher`s aim was not to generalize to the results to the all 4th and 5th graders, teachers, or parents. The sampling was purposeful, targeting the voluntary students only those who are interested in science. The reason why purposeful sampling carried out was because the intent of the study was to examine students` uses of SIS in science learning. However, this increases the possibility that sample was not representative. In contrary to the some other researchers conceptualizing qualitative research as a limitation as they find the sample size not representative, the researcher's viewpoint to the qualitative studies is that they provide richness in understanding the meanings of the actions and notions, and help digging into the concepts which is a way to make sense of the things from participants` in-depth views. Rather than the generalization issue which is not a limitation for this kind of studies anymore, the researcher will highlight the logistical drawbacks faced with in the study.

In the first place, the researcher encountered a drawback during the data collection process. As science theme passed at the time data collection in Private School B, classroom observations could not be conducted in this school. However, the researcher proceeded to collect data as the school had been implementing a different program called International Baccalaureate Primary Years Program (PYP) for all students up to the end of Grade 5. The program was briefly based on transdisciplinary relationships between different disciplines and it aimed to combine social and science units. International Baccalaureate Organization explained the aim of PYP as follows:

> The PYP aims to synthesize the best research and practice from a range of national systems with the wealth of knowledge and experience in international schools to create a transdisciplinary curriculum which is relevant, challenging and engaging for learners in the 3-12 age range. (p.3)

Thus, in order to enhance the variation in sampling, this school was also included in the study. Moreover, the researcher had a chance of watching a couple of peviously recorded science course sessions from the science lab teachers` archive, and took some observational notes through those records to complement the interview findings. She did not eliminate the school from the study to have variation in sampling, and besides the classroom videos she asked further questions to the students and teachers in order to understand the classroom dynamics better.

Another limitation was related to the data collection instrument used in the study. As noted earlier in the chapter, the students were interviewed in focus groups. Besides its advantages, focus groups were not without their drawbacks as also discussed by Morgan (1998). According to Morgan (1998), data collected through focus groups were less than individual interviews with the same number of participants. However, eight focus groups were formed in four different schools to minimize the potential risks of using the focus group interviews. In addition to this, the interview data were complemented with classroom observations and documentation.

CHAPTER IV

RESULTS

In this chapter the results of the qualitative data analysis are presented under three major headings with respect to the research questions: (a) Science information sources (SIS) in students` use, (b) different intents and purposes in employing various science information sources, and (c) effective and ineffective uses of SIS in learning science. The first part deals with the main characteristics of the SIS, the sources typically used in school-based and school-beyond contexts along with the directive and directed sources. The second section covers the uses and different purposes of using SIS reasoning from students` cognitive, affective, personal and social integrative needs. The last part provides the results in relation to the effective and ineffective features and uses of SIS in science learning.

With an aim to establish the connection between science communication to science education in mind, patterns, themes and categories that were defined parallel with the research questions are presented in this section. At first, the results are presented seperately, grade by grade considering the school types. Yet, as the analysis for private and public schools and different grades produced similar patterns, the researcher chose the present results regardless from the grade level and school type, though she highlighted occasional differences between the two groups and between the private and public schools when necessary.

4.1. Science Information Sources in Students Use

Science information sources that the students used emerged as one of the themes as a result of the qualitative data analysis process. At the beginning of the focus group interviews, students were asked for their access to science information. Then, they were asked about their uses of various sources including media (TV, internet, newspapers, science magazines) and other sources (teachers, families, textbooks, science books, educational software products, science centers/museums, science exhibitions, science camps) in their daily routines for science related purposes.

The analysis of the study revealed that all students interviewed had internet connection both at home and at school. However, interviews and observations revealed that students at private schools had more access to internet at school in comparison to their mates in public schools. Students were less likely to access science information by reading newspapers than they were by watching TV, using internet, or reading science magazines. As illustrated by Figure 4.1, newspaper use for science related issues left behind among the other media sources.

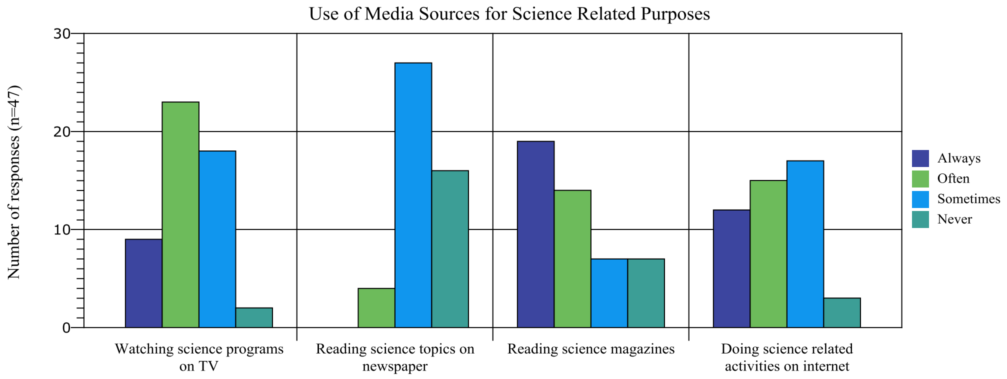

Figure 4.1. Students` use of media sources for science related purposes.

Apart from the use of internet, newspapers, and TV, the results revealed that the textbooks and various science books were used quite often by the students. Teachers and families as the SIS were the other key sources in students` science learning. However, unlike the aforementioned SIS, science exhibitions and science camps were not found preferable in accessing science information as seen in Figure 4.2. It is important to note that students did not visit science museums/centers and science exhibitions unless the trip was arranged by their schools.

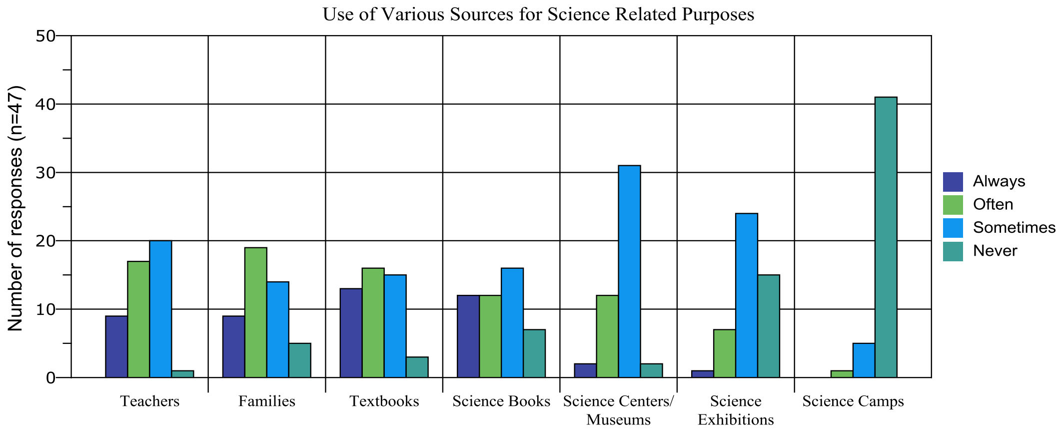

Figure 4.2. Students` use of various sources for science related purposes.

The features of those SIS, their uses, and processes along with their effective and ineffective features are presented in detail within the following sections.

4.1.2. Main Features of the Science Information Sources

The first research question addressed in the study was the sources the 4th and 5th graders used in science learning. With this in mind, SIS were categorized and their main characteristics were presented under two headings with regard to the contexts they were typically used: School based science information sources and science information sources beyond school.

4.1.2.1. School-based Science Information Sources

Classroom observations and interviews conducted with the teachers and students revealed that students` main science information sources in school based contexts were their teachers, textbooks, science books (TÜBİTAK, Batı Akademi, Timaş, Ata, Koza publications), their classmates (e.g., group working, role-playing, presentation, discussing), and educational software (e.g., Morpa Kampüs, Ttnet Vitamin, Zambak with web-sites like slaytyerim.com, slaytizle.com, fenokulu.com) as illustrated by Figure 4.3. Among these educational programs, Morpa Kampüs was provided to all schools free by the

MoNE. In order to present a detailed picture of SIS, each science information source highlighted by the interviewees was handled with their basic features next.

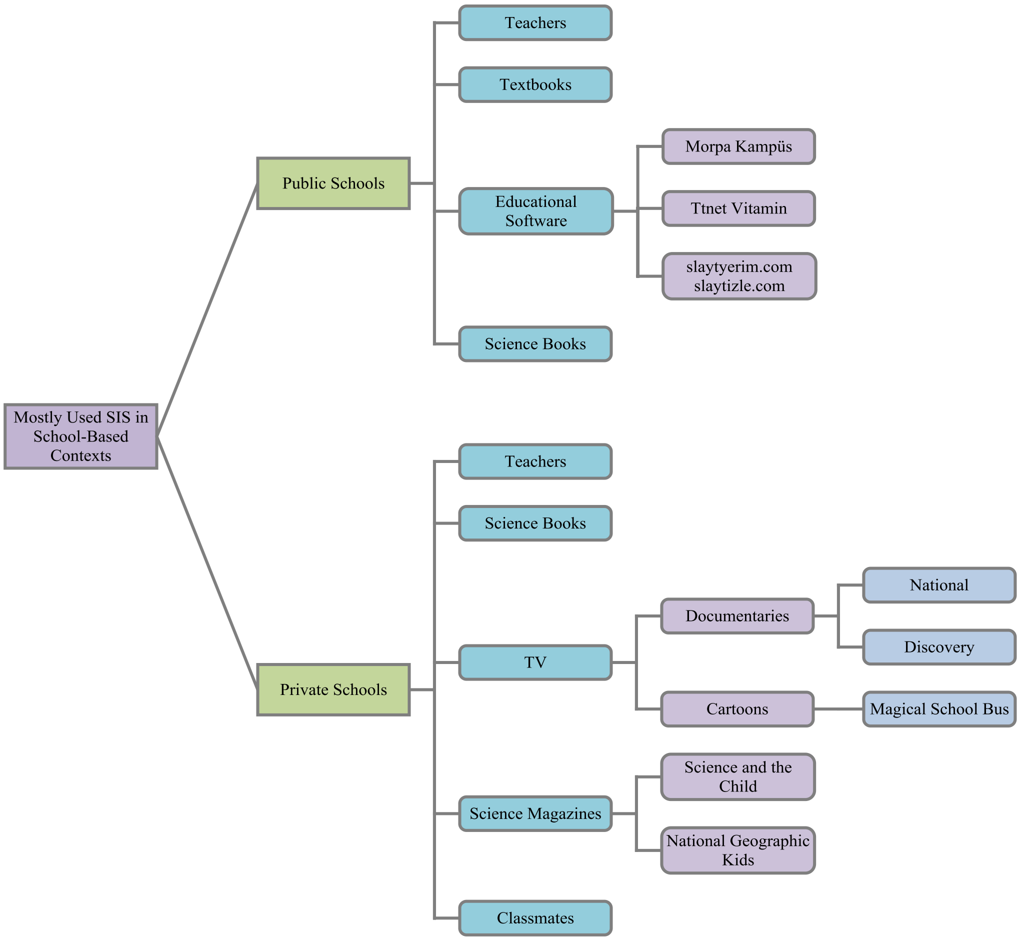

Figure 4.3. Mostly used SIS in school-based contexts.

To begin with, the analysis of the data revealed that *teachers* were typically students` primary sources in school-specific contexts. According to the observation and interview analysis, students were found to apply for their teachers for some science learning purposes like homework-project related research, individual science research, and exam-test preparation. The results revealed that it was possible to interact with teachers individually which was a way to facilitate students` science learning. In saying this, human to human interaction was highlighted many times by students. To illustrate, one of the 4th grade students from Public School A, S5 believed that:

> …it [human to human interaction] is more enjoyable and better. When you ask something to the TV, it doesn`t reply anymore, but when you asked it to your teacher, she replies, accordingly.

According to the analysis of the transcribed interviews conducted with students, teachers, and classroom observations, teachers were also found to be guiding and sometimes directing students to the other science information sources which were conceptualized as an advantage or sometimes as a disadvantage by various participants. Here, teachers were identified as “directive” sources while channeling their students to the internet, families, and science books when students asked science related questions to them. In parallel with this, internet, families, and science books were labeled as “directed” sources. To start with its advantages, some of the students believed that their teachers directed them to the other sources if their teachers were not sure about their knowledge. Moreover for some of the students, learning science from various sources facilitated their learning and they found it useful when their teachers directed them to the other sources. Teachers reasoned that rather than providing readily fed data, they preferred to direct students to the other sources because they believed that by doing this students did not only gain research skills but also they learnt the things permanently while benefiting from the other sources, as well.
For instance T6 responded that:

> Students believe us, they think that if teachers say it, it must be absolutely true. I do not prefer to say: Absolutely true or false to something unless I am confident. (…) If I am not sure I direct them to the other sources and make them explore [what they want to learn about] from different sources.

The analysis of the data further revealed that teachers` being directive sources held some perceived disadvantages from the point of the students. As a disadvantage, some of the students claimed that they couldn`t learn when their teachers did not give them the answers promptly. Disagreeing with her teacher`s method, S25 (5^{th} Grader, Public School A) responded that:

> I ask a question to the teacher, the teacher sometimes speaks like a puzzle. I say: “Teacher, please tell the answer!” but the teacher says: “Go and research by yourself”. I think this is not satisfactory anymore and sometimes I really need an exact explanation about the concern. Sometimes she does, but I do not feel it is sufficient, either.

Differentiating human and non-human sources in science learning, T11 also mentioned that interactive communication with eye contact and body language was always different from the other ways of communication. As a corollary of these advantages, T11 found that teachers and classmates as human sources were effective in students` science learning. Surprisingly, S14 (4th Grader, Private School A), used "computer" metaphor to her teacher. She commented that "Teachers work like computers, when you need information, you ask and get feedback like computers [or mainly google she meant]."

Next, *classmates* were the other science information sources as reported by the interviewees. The students in the study were found to collaborate with each other for homework-project purposes and exam-tests preparation. As T8 stated:

> Peers, classmates might be a good source of information in their learning because they may affect each other. If one of them learns something new he comes and shares it with his/her classmates. It might be with game cards, or science information they share. Classmates are effective.

When it comes to the *textbooks,* both public schools and private school B had common MoNE textbooks which were prepared seperately for each grade. In this book, students chiefly enjoyed the following parts, "Information Drop" (Bilgi Damlası), "Do and Observe" (Yap-Gözet), and "Do You Know Those?" (Bunları Biliyor Musunuz?). Exceptionally, in Private School A, for the 4th grades they used their own published textbooks as different from the provided textbooks by the MoNE. However,when this book was compared with the common textbooks, both were found to have a common plan through the national curriculum and display the same subject flow. When the teachers were asked about the reason of using a different textbook for the 4th graders, they replied that the book was written by school teachers and that is why they thought this book was more appropriate to the students in their school. Moreover, in Private School B students were making use of supplementary books besides textbooks in science courses. Actually, both private schools were found to support science courses with additional worksheets and they were in a preparation for publishing notebooks for students to be filled by students for the next semester. What is more, in contrary to the public schools, classroom observations and interviews indicated that textbooks were not among the main science information sources in private school students` science learning. Based on the analysis of the observations and interviews, students seemed to use the textbooks mainly in school specific contexts, and during science classses for some purposes like homework-project purposes and exam-tests preparation.

The analysis of the transcribed interviews conducted with the students also revealed that textbooks were another "directive" source in science learning. When students conducted science research from textbooks for various reasons such as doing homework and projects, preparation for exams and, they sometimes needed to do further research from the other sources like other science books, internet, their teachers, and parents. By way of illustration, S12 commented as follows:

> "Information Drop" [a section in the textbook- Bilgi Damlası] really attracts my interest. Whenever I read it I conduct further research on the internet. This is better. I learn better in doing this.

Besides the science textbooks, the analysis of the data also revealed that students employed other *science books* from a range of publications such as TÜBİTAK, Ata, Batı Akademi, Tudem, Koza, and Timaş. The 4^{th} and 5^{th} graders in the study were found to read about mainly space, human body, and animals. Interview and document analysis indicated that students used science books for individual science research, homework-project purposes, and exam-test preparation, as well as utilizing these books during the science classes.

Educational software products like Morpa Kampüs, Ttnet Vitamin, and Zambak with some of the web-based programs (slaytyerim.com, slaytizle.com, fenokulu.com) were the other SIS revealed through the data analysis. Among these programs, Morpa Kampüs is provided to all public schools free of charge by the MoNE. Most of the students reported using these software during science classes. Exceptionally, students in Private School A emphasized that they did not use educational programs like Morpa Kampüs and Ttnet Vitamin in school based environments, but they sometimes employed these programs in school beyond environments. Participants explained that these kinds of software products were useful since they were in harmony with school curriculum. In line with this, according to T9, educational software products reinforced the school science subjects. Moreover, in the same vein with the students, P7 and P8 commented that educational software products were easy to access, and effective with its visual, audio and animated features.

In private schools, as different from the public schools, textbooks and educational programs were not found the main sources in students` science learning in school-based contexts. Except from those sources, internet, science books, documentaries, classmates, and science magazines (Science and the Child, National Geographic Kids) were main references besides teachers in students` science learning. Moreover, private school students indicated that they also used the TV in school specific contexts. They reported watching cartoons like “Sihirli Okul Otobüsü” (Magical School Bus), Marvi Hammer, and various National Geographic and Discovery channel documentaries that their teachers or peers brought to classroom. In addition, unlike the public school students, private school students, highlighted science laboratory experiments with the teachers as a SIS. This further revealed a discrepancy that was explained by the absence of science laboratory sessions in public schools. Students chiefly in private schools also added that they learnt science from their classmates.

When students were asked about the kind of science information they learnt up to the point of interview, they gave examples that were mainly related to the science curriculum, indicating their clear association of science with in-school contexts. For instance, S9 (4th Grader, Public School A) stated that everything her teacher said or written in the books [meaning textbooks] were science. Furthermore, S14 (4th Grader, Private School A) asserted that they learnt elimination and separation methods, the second unit topic in the previous semester: “Let`s Know Matter” (Maddeyi Tanıyalım). S5 (4$^{th}$ Grader, Private School A) added that they learnt about the layers of the planet [2$^{nd}$ semester, Unit- 5, Our Planet Earth (Gezegenimiz Dünya)]. S44`s (5th Grader, Private School B) response was broader than the others covering many school science units. He said:

I learnt how circuits work, animals, human body, skeleton, expansion, contraction, and many science experiments.

[These topics correspond to 2nd Semester- Unit 7- Electricity in Our Lives (Yaşamımızdaki Elektrik); 2nd Semester- Unit 6- Let`s Get To Know Living Creatures` World (Canlılar Dünyasını Gezelim Tanıyalım); 1st Semester- Unit 1- Let`s Solve the Puzzle of Our Body (Vücudumuz Bilmecesini Çözelim); 1st Semester- Unit 2- Let`s Know Matter (Maddeyi Tanıyalım)]

4.1.2.2. Science Information Sources Beyond School

The science information sources beyond school were produced as the next sub-theme as a result of the analysis of the transcribed interviews with the participants. The 4th and 5th graders in this study underlined "fun" and "enjoyable" characteristics of science activities out of the classroom. In line with this, TV, internet, science books, families, science centers/museums, and science camps were found to be the sources to which entertaining aspects attributed. Among these sources, science books (e.g., TÜBİTAK, Tudem publications) and websites like Google, Wikipedia, and even Facebook were among the mostly used sources in school-beyond contexts.

Students watched science channels (National Geographic Channel, Discovery Channel), scientific documentaries, cartoons, and scientists on TV. They added that they read science magazines named "Science and the Child" and "National Geographic Kids". Families including their parents and siblings and relatives were found to be the other science information sources for children. As noted above, students reported learning science from science centers/ museums (e.g., METU Science and Technology Museum, MTA, Feza Gürsoy Science Center) which they visited either with their schools or their families. Among the school-beyond context sources, newspapers, science camps, science centers/ museums, exhibitions/fairs were not as popular as internet, science magazines, science books, or families. From a different perspective, when the topic was school-beyond sources, parents and teachers thought that children were not conscious enough to choose appropriate content for themselves. Therefore, they needed guidance in using those sources especially the internet. Mostly used SIS in school-beyond contexts were shown by Figure 4.4.

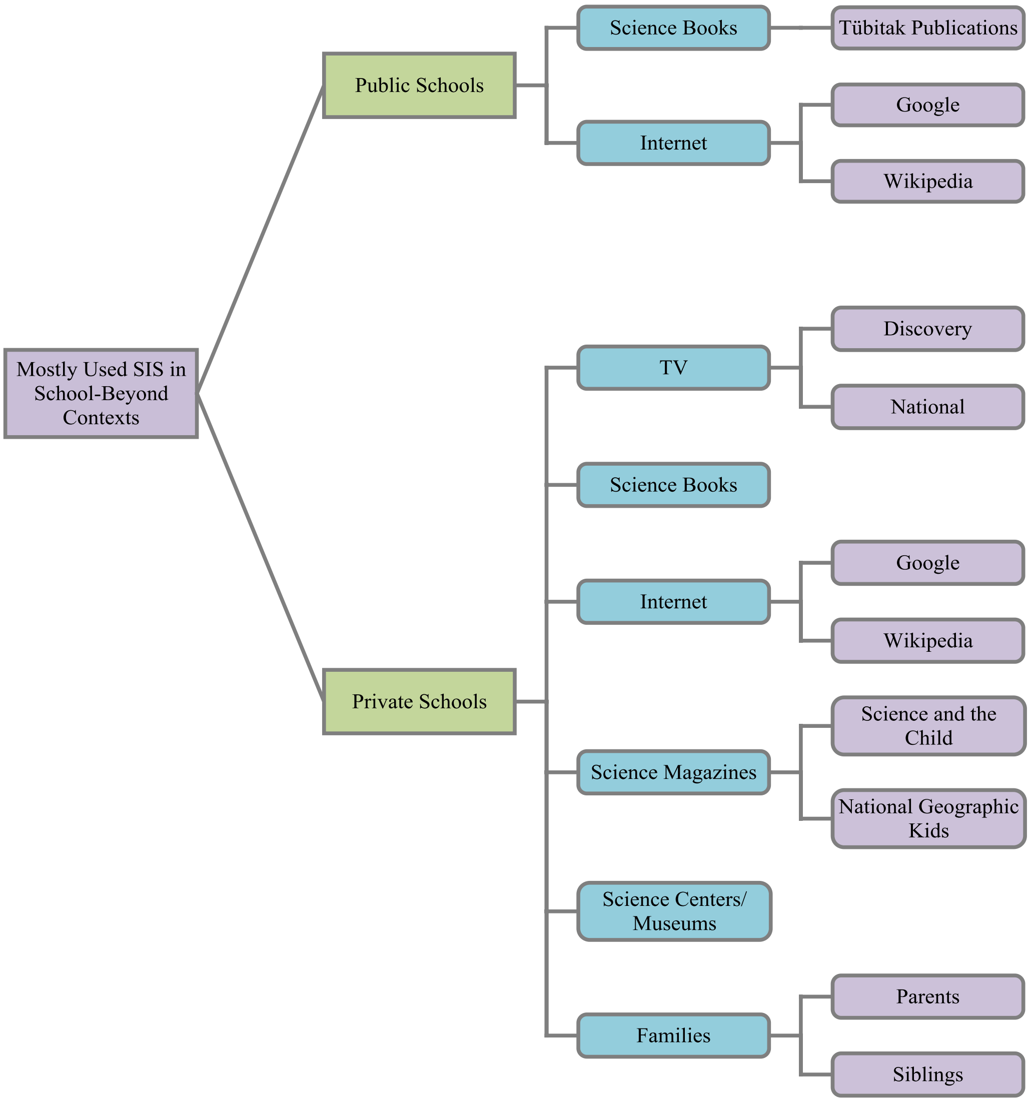

Figure 4.4. Mostly used SIS in school-beyond contexts.

TV emerged as the mainly used SIS that was used in school-beyond contexts based on the analysis of the interviews conducted with the students, teachers, and parents as well as the observations. It was found that students used the TV for individual science research purposes and homework-project research. They preferred to watch channels like "National Geographic", "National Geographic Wild", "Discovery", and "Yumurcak TV" in learning science with the programs called: "Myth Busters", "Ultimate Survive", "Marvi Hammer", "Dog Whisperer", and "Backyard Science" (Arka Bahçede Bilim). It is important to note that the 4th and 5th graders` favorite subjects on TV were animals, nature, mechanical issues, and space. In relation to the features of the TV as a science information source, students mainly mentioned that they enjoyed learning science from the TV as it was both auditory and visual. To illustrate, S3 (4th Grader, Public School A) further claimed that TV also made him feel like he lived in the actual environment he saw while he was watching science related programs. He commented on this as follows:

> When I see the information on TV…It is better because it is both audio and visual (…). It gives the feeling of tactile even we cannot do it anymore. As TV has these three features I learn it [science] better on TV.

According to the students, TV presented authentic, updated, short, and direct information which might be repeatable (it might be recordable or might be watched again). TV as a "directive" SIS was reported to orient the students to the other sources like teachers, families, internet, and science books if they had further questions in relation to the science topic they watched. Accessibility was another advantage of the TV as a science information source. According to the interviewees, access to the TV was available in almost all households, and this was one of the reasons making TV among the most effective science information sources.

Subsequently, according to the analysis of the data gathered through the interviews and observations, students were found to use *magazines* in school beyond contexts mainly for individual science research purposes and sometimes for homework and project purposes. Again, interviews and observations indicated that students were enthusiastic about sharing the things they had learnt from science magazines in both class environments and at home with their parents. Furthermore, the students explained that when they read something in science magazines they would like to learn more about the topic. In other words science magazines as "directive" sources were orienting them to the other sources, namely, teachers, families, internet, and science books.

"Science and the Child" (Bilim Çocuk) and "National Geographic Kids" were among the students` favorite science magazines. Students` favourite parts in National Geographic Kids were: "Strange but Truth" (Garip ama Gerçek); in

Science and the Child: “Bagel and Cheese” (Simit ve Peynir), “Our Street” (Bizim Sokak), and “What is There, What isn`t?” (Ne Var, Ne Yok?). Some of the children added that their parents or siblings were subscribed to “Science and Technique” (Bilim Teknik) and National Geographic, and they sometimes read these magazines, as well. As different from the others, one of the 4th grade students in Private School A said that she also followed a U.S. based science magazine named: “Kids News” which her father bought for her. What is more, there were some teachers who introduced magazines in the classroom environments and suggested their students to use those magazines. For illustration T2 and T5 suggested their classes using science magazines and especially T5 insisted her students to buy “Science and the Child” and obligated her class to read this magazine starting from their 3rd grade.

The results also revealed that the additions of the magazines like mauqettes, cards, and gifts were highly motivativing for the students that encouraged them to subscribe to or purchase those magazines. In line with this, P3 and T14 thought that one of the reasons for students to keep following those magazines was their additions. Below are two representative student quotes that highlight the importance of the additions in students` magazine preference:

> I read “Science and the Child”. It is for children and easy to understand. Pictures, additions, and so on, I like it. Its additions are also related to the science…It is enjoyable. You both learn science and enjoy it. (S46, 5th Grader, Private School B)

> I read science magazines like “Science and the Child”. It is easy to understand because it is prepared for our level. It takes my interest because it presents the content with examples, visuals, and it gives various additions. It is enjoyable. (S32, 5th Grader, Public School B)

The other SIS typically used in school beyond context was *newspapers*. Although newspapers made science more accessible to students, it was apparent from the interviews and observations that students did not prefer to read newspapers either in science learning or in general meaning. However, S45 (5th Grader, Private School B) compared actuality of the newspapers with the internet, and said:

> Newspapers update themselves everyday. I learn recent science related news from the newspapers. It is also more trustable than the internet. That is why, I prefer newspapers.

Next, the *internet* was among the SIS used heavily for individual science research, homework, project purposes, and preparation for exams and tests. In fact, the analysis of the data revealed that the teachers complained about the internet being a primary science information source for the students and told that they directed their students to books and other sources when they had homework or a project in relation to science. On the other hand, some of the students posited that when they asked something about science to their parents, their parents directed them to the internet for a comprehensive search. The analysis of the interviews also indicated that the students had a limited access to the internet in both learning contexts (school-based and beyond) as the MoNE had some restrictions in school based contexts as the parents did in school beyond contexts.

The analysis of the data revealed that the internet use of the students had a pattern. Students said that they basically used Google as a search engine and Wikipedia in their science related research. Some other students added that they also had science video sharing on their Facebook group. Complementing what the students said, the teacher of those students substantiated that she opened a group on internet when she discovered that students were active on Facebook. She explained that she wanted to channel students interested in Facebook in a more positive direction, namely, sharing science on Facebook through a group. Again, T17 shared her observation and commented that the students spent most of their time on Facebook. Coming from this angle, she explained that she found Facebook useful to motivate students towards science in terms of sharing scientific advertisements and videos.

Furthermore, the internet was emerged as an accessible and user-friendly source for students as well as a result of the analysis. Giving the priority to the internet, S19 (4^{th} Grader, Private School B) explained that he mainly used the internet in his research on science as TV or newspaper did not provide the information for him whenever he needed. In parallel with the student interviewees` thoughts and perceptions on internet as SIS, for P9, internet was an accessible source with rich and visualized content. Similarly, S31 (5th Grader, Private School A) also mentioned the accessibility of the internet:

> People used to get information from encyclopedias. But now, they just use the search engine and access the information, directly. It is easier and makes the best of one`s time.

Moreover, the analysis of the interviews revealed that, the students applied for their *parents, siblings,* and *close relatives* in relation to their homework-project related research and for their individual science research. As different from the siblings and relatives, students were found to ask for their parents` help while they were studying for their exams-tests. Surprisingly, they were mainly in a tendency of choosing their family related science sources on criteria basis. In other words, students were selective about choosing the "right" expertise family member in relation to their specific science questions. To illustrate, S1 (4th Grader, Public School A) said:

> I do not ask my science questions to my father but [I] rather [to ask] my mom and brother. Because my father professionalized in social subjects but my mom is an engineer and my brother is studying science and maths. Sometimes my brother explains the things in a very complex way without degrading it to my level. Then, I go to my mom and she explains the things in a way I understand better.

In line with S1, P10 responded that:

> Always, he does…[asks science related questions] He asks technical questions to me [he works as a technical training teacher], and health related questions to his mom. His mom is a nurse.

Thus, the data analysis indicated that educated parents were mainly conceptualized as a successful science information source among interviewee parents and teachers. Comparing educated and non-educated parents, P6 concluded that educated parents would be helpful in communicating science information to their children. Otherwise he continued that he did not find it useful to learn science information from any parents or family member. In line with this, one of the students was found to consult to his cousin for science related issues as he was a genetic engineer and his parents were too busy during the day.

Explaining the different methods that their parents used when they asked science related questions to them, some of the students stated that their parents did not give them direct answers regarding their science questions. Rather than this, they said that their parents directed them to the other sources. In this case, parents became “directive” sources while orienting their children to the internet and science books when they had science specific questions as shown in Figure 4.5. As illustration, P10 responded that he directed his child to the internet when he asked science related questions to him. What is more, P1, P3, and P6 added that their children consulted to them if they had questions on what they watched on TV. In this case, TV was a directive source whereas family was a directed source. S16 illustrated that whenever she asked science related questions to her parents they never told her the correct answers since her parents thought that this was not an effective way for their child`s science learning. Instead, they directed her to the other sources, especially internet while finding appropriate web-sites for her to read. In doing this, her parents believed that researching from various sources constituted permanent knowledge in her mind in comparison to giving direct answers to her questions. Moreover, T2 commented that parents` interest towards science was in proportion with their children`s interest in science. According to the interviewee teachers, family, especially parents` support was critically important in terms of child`s interest in science. They reasoned that children were also being affected by what they saw in the family environment.

When it comes to the siblings, students also mainly preferred to learn science from their older siblings who were studying on science and mathematics subjects. In this context, in determining future careers, siblings were very important in students` choices. P9 shared his observation on her child as follows:

> His interests are human body and space. He would like to be a doctor in the future. His siblings are both studying medicine. He might have been affected from them.

The results revealed that close relatives like cousins, aunts were also mainly applied for in learning science. Students explained that those relatives had science related careers such as biology and engineering. The qualitative data analysis indicated that educated parents or family members who were professionalized in related science subjects were quite helpful to the students but if they were not, students explained that they did not apply to their family in learning science as they did not find the science information trustable under these circumstances. For instance S34 commented that:

> Some of my friends said that they asked their science questions to their parents since their parents had science background. If parents know about science it is ok to ask, but if not they may not be providing valid responses.

Students were found to visit *science centers/museums* with their schools and families though most of the visits were school-guided. ODTÜ Science and Technology Museum, Feza Gürsoy, Rahmi Koç and MTA were mostly visited museums in Ankara. One of the private school students added that she also visited science museums while she was in the U.S. Students explained that when science centers and museums had interesting exhibits and activities which were "directive", and they conducted further research using the other sources like teachers, families, internet, and science books as summarized by the Figure 4.5.

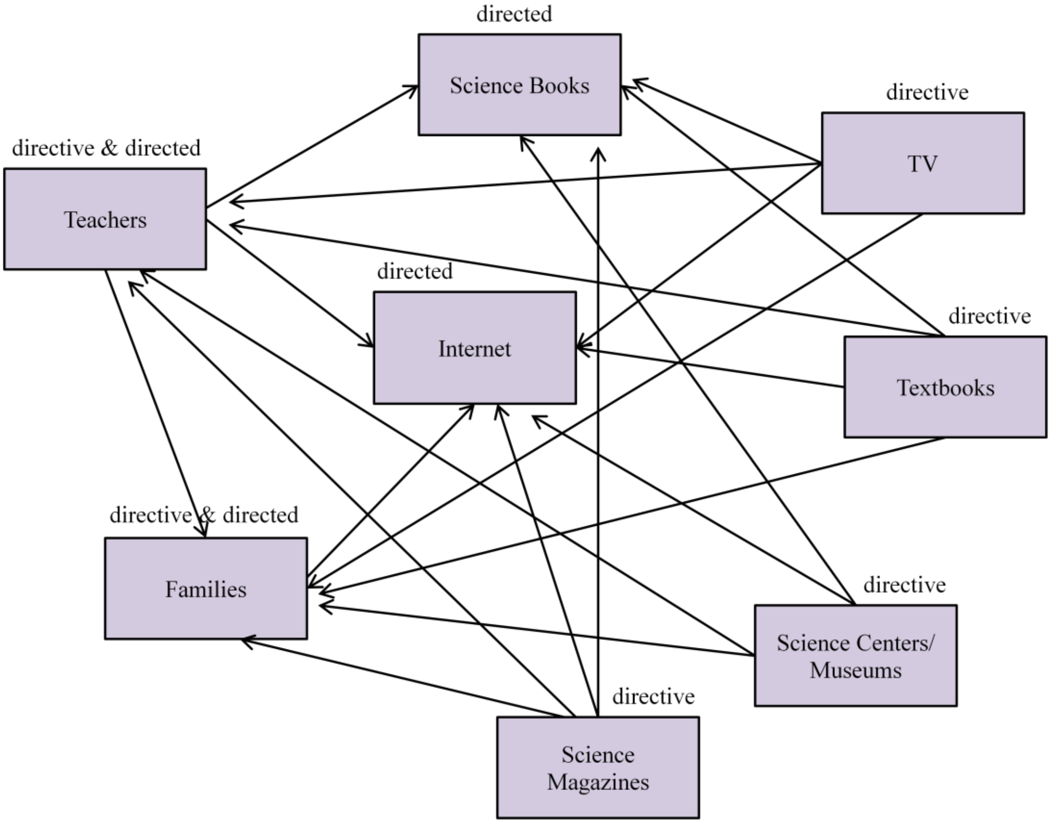

Figure 4.5. Directive and directed sources.

In addition to the science center/museum visits, students also reported participating in the *science exhibitions* in their schools or in performance centers, shopping centersand similar placesaround them. Most of the students visited science exhibitions with their families. “Leonardo da Vinci” exhibition was found as one of the mostly highlighted science exhibitions students had ever visited.

The data analysis also emphasized the role of the science camps in students` learning science. Science camps were found to enable the students to learn on their own and/or with their peers away from their teachers and parents.

As for the participation of the students in science camps, among the 4th grade students, there was no student participation to the *science camps*. On the other hand, there were four 5th graders having attended a science camp, one of whom was from Public School B (Ankara University - Child University), the other was studying at Private School A (ODTÜ - Teknokent Science Camp), and two of them were from Private School B (Ankara University - Child University, İzmir - Space Camp). One of the teachers in Private School B added that some of her students had also the chance of participating science camps abroad. “İzmir Space Camp” was students` favorite among the other science camps.

4.2. Uses of SIS in Students` Learning Science

The analysis of the interviews and classroom observation fieldnotes revealed that the uses of the SIS differed in students` learning science. In the first place, based on what was said in uses and gratification theory, people made use of the media for their specific needs. With a broader perspective to the U&G theory, students in this study used various sources besides the media to meet their different needs. According to the data drawn from the study, students` needs and gratification were examined into four categories: (a) cognitive needs (gaining information, knowledge, and understanding), (b) affective needs (needs related to strengthening aesthetic, pleasurable, and emotional experience), (c) personal integrative needs (strengthening credibility, confidence, stability, and status combining both cognitive and affective elements), and (d) social integrative needs (strengthening contact with family, friends, and the world). These needs were sometimes found to interfere with each other, thus the researcher abstained from drawing harsh lines between them. The data analysis further revealed that the students employed various SIS in satisfying their needs in relation to meeting their homework-project requirements, preparing for exams or tests, and doing individual science-related research. There were also the uses of SIS in relation to the science classes and distribution of science related findings. Students` needs and usage of science information sources are shown in Figure 4.6.

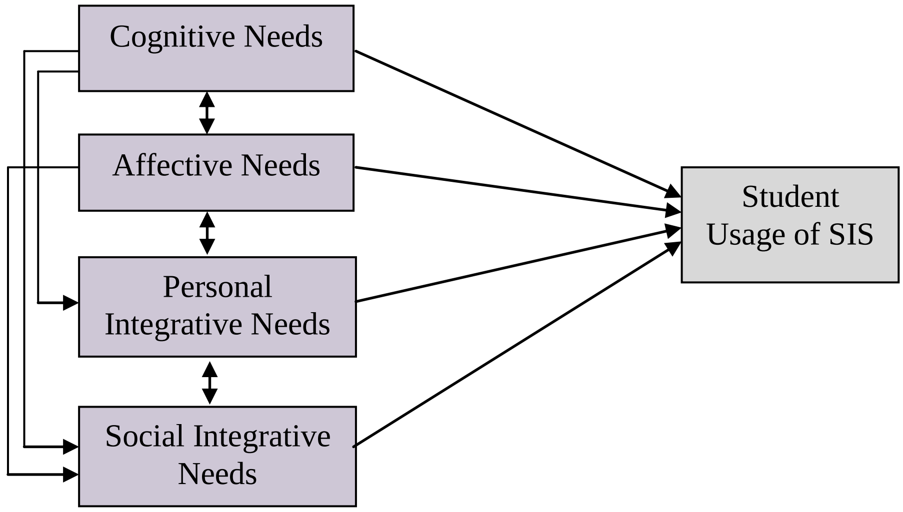

Figure 4.6. Needs and usage of SIS. *Note.* Arrows in the left indicates the relationship between the needs.

4.2.1. SIS Used for Homework/ Project Requirements

The analysis of the data revealed that the students drew on textbooks, science books, internet, and consulted to their teachers and parents, or worked in groups with their classmates when they had homework or projects, which was found as one of the uses of SIS.

The cognitive needs significantly underlined this use. In other words, students` needs were related to expanding their information knowledge with regard to a specific science topic when they used SIS for homework/project purposes. Figure 4.7 summarized the SIS that were employed by students.

Students` main science information source when they had homework or projects was the *internet* although teachers and parents complained about this. In other words, most of the students mainly used the internet when they had a specific science related question as represented with the following quote:

> I did my homework using internet. (…) It is an easy way to access information. When you write [something] on Wikipedia it gives all the information directly and the only thing I do is to write it down with my own sentences. (S17, 4th Grader, Private School A)

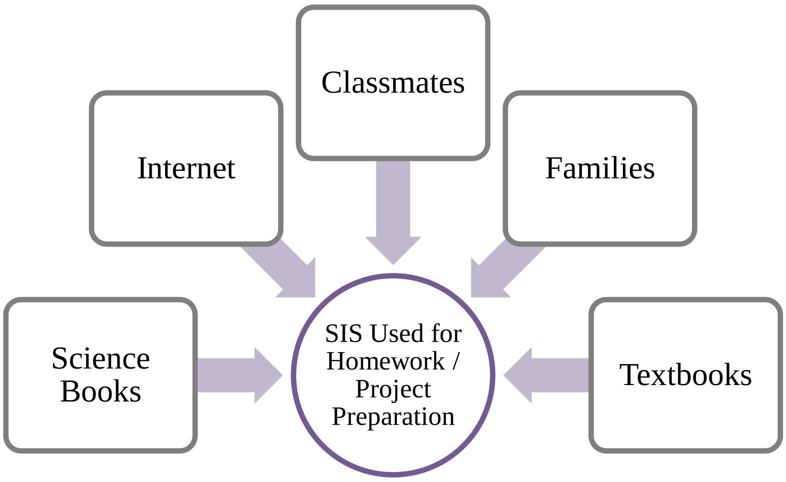

Figure 4.7. SIS used for homework-project preparation.

Students reported using the internet for homework purposes while reading the information accessed, organizing, and re-writing the information on their own ways and sometimes printing out pictures and visual elements to be inserted into their homework/projects. During their internet research, students reported that they were aware that some websites did not provide trustworthy information. Accordingly, they said that they used the websites that their teachers and parents suggested. Here, it is important to note T9 was opposed to students` using internet or asking their parents because those sources provided the students with the “readily fed data” and this did not serve the nature of science homework.

Sharing their observation on students` using SIS for homework purposes, most of the teachers explained that the students firstly used *textbooks*, subsequently asked their teachers. Following this, they applied to the other sources to acquire further information about the topic investigated. By way of illustration, P2 shared his observation on his child while he was doing his homework:

> If there is a homework requirement, they probably would like to see information from the other sources not just the textbook. This provides him [my son] to access the other aspects of the information [that is not mentioned in the textbook]

In this description, textbook was described as a directive source (as mentioned earlier) and a kind of reference source to give the rough data and direct students to the other sources. Apart from this, the students` textbook use for homework and projects was based on reading the texts, writing down the information on the textbooks to the notebook, or simply searching for the topic under investigation.

Classmates emerged as the other SIS enabling the students to do their homework and/or meet their project requirements. The data analysis revealed that the students sometimes worked in groups to do homework/projects. According to the observations and interviews, teachers were also found to group the students to prepare presentations about the science subjects. Similarly, P10 responded that when his child had homework, he mainly prepared it with his classmates together. The analysis further revealed that homework/project or presentation based collaboration with classmates mostly encouraged change in group dynamics as the students shared the tasks with each other.

The other science information sources applied for homework purposes were *science books* and *families*. The students reported using science books to get detailed information about the topic. Testbooks were also examined under this category. Furthermore, students asked for their parents` help and did the homework/project with parental support. To demonstrate, some students said:

> First, we bought the materials. I would not know how to do this [the project] that`s why we checked the books [science books]. My parents taught me how to do it and, then they did, I watched them. Afterwards, they bought the materials [again] and we did [the whole project again]. (S10, 4th Grader, Public School B)

> The last homework was to design our garden. It was really fun. I used the internet, textbook, and my parents. These sources provided me quality

information which was easy to understand. There was some information on the internet like “if you do this and this your plant grows up” and I read them all and applied these [to my garden] step by step. My parents experimented with the things they already knew, as well. I also searched it from the textbook and I implemented it. (S4, 4^{th} Grader, Public School A)

I do not prefer to read the things from the book, thus I ask my father. He teaches me better and it becomes permanent in my mind. In addition to that my father knows some of our research topics. (S13, 4^{th} Grader, Private School A)

From the view of the parents, teachers` homework or project requirements were useless because their children did not research it using various sources as teachers assumed. Instead, the students mainly trusted the internet or they (as parents) did their children`s homework. Therefore, some of the parents thought that doing their children`s homework with them or directing them to the other sources in an unconscious way did not serve its aim. Moreover, surprisingly, P7 complained about doing too much of his child`s homework at home:

Parents always wait besides their child while s/he is doing his/her homework. Parents become students with their children. Every year, schools open in September, and parents` studentship continues till the end of school year in June. You study hard with your children, too…You become a student, a teacher, and a parent at the same time.

4.2.2. SIS Used in Science Classes

The analysis of the transcribed interviews and classroom observations revealed that there were certain SIS used during the science classes, as well. Accordingly, science books, teachers, classmates, educational software, and textbooks were the sources used in science classes as illustrated by Figure 4.8.

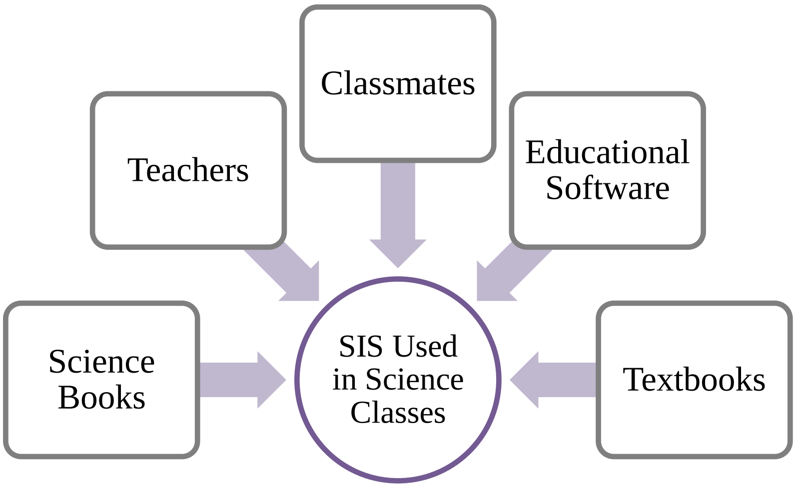

Figure 4.8. SIS used in science classes.

Contrary to the other uses of SIS, this type of use was mainly guided by the teachers. In both public schools, textbooks and teachers were found to be the dominating SIS in a typical science course. However, on the contrary to the public schools, textbooks were not reported and observed as the main sources in private schools. During science classes, private school students used science books besides textbooks, watched science related documentaries and cartoons, and discussed about the scientific concepts with their teachers and classmates. The students` uses of the SIS during science classes basically referred to their cognitive needs such as the need for information about science and the wish to study. However, there were some exceptions about their affective needs (having fun with the science drama activities, science games, laboratory experiments, science cartoons, and documentaries), and social integrative needs (being praised by teachers and classmates when sharing information in the class).

Here, it is crucial to note that most of the students admitted that they learnt most of their science in science classes. Among these sources, teachers were identified as one of the most effective SIS in students` science learning. According to P8 and P1, teachers` words were almost like law for their children. Therefore several parents commented that teachers were very effective in their children`s learning science. To illustrate, S9 (4^{th} Grader, Public School B) commented on this as follows:

> Everything our teachers said, everything we read from the books [textbooks] is science.

The analysis of the interviews and observations revealed that especially while the teachers introduced a new chapter, students read the topics in the textbook aloud and meanwhile teacher added something where necessary in the public schools. Many times, students reported finding this activity as “very boring.” Some of the representative quotes are as follows:

> At the beginning of a new chapter teacher asks us what we knew about the new topic and she explains the topic. Then, we read the topic in order to understand the subject better. The teacher sometimes stops the reader and adds something. She also asks questions about what we have understood and what we have thought [in relation to the topic]. (S18, 5th Grader, Public School B)

> (…) We read the textbook, do extra studies from textbook but apart from this our teacher distributes handouts and we also study using these [handouts]. (S5, 4th Grader, Public School A)

S32 (5th Grader, Public School B) said that her teacher supported her science class with examples, and repeated what she said when the students did not understand the topic. That is why, she found her teacher contributive to their science learning. Apart from this, the students also found the lesson fun and enjoyable when they played games or did drama activities in learning science as illustrated by the following quotes:

> Our teacher plays word-games with us. She gives some clues about the subject and while we are trying to find the word we are like covering the subject again. That`s why I love it. (S18, 5th Grader, Public School B)

> I understand it better [science subjects] when my friends do a drama activity in class and then do a presentation in relation to the topic. (S9, 4th Grader, Public School B)

As seen from the quotes, students were also found to learn science from each other. According to the observations and interviews, students shared the information they had learnt through those sources like books, magazines, TV, and internet with their teachers and classmates. By way of illustration, two students commented as follows:

> When I watch documentaries, I share it with my classmates while we are on the subject so that they could understand the subject better. (S12, 4th Grader, Public School B)

> Sometimes there is some information that my friends do not know. I talk about it and I inform them [other students]. (S1, 4th Grader, Public School A)

Especially private school students implied that they brainstormed about the various aspects of the topics among each other in science classes and this made science subjects more understandable and permanent for them. For example, following student said:

> Our friends also bring some sources to the class, they read them and we learn it [the science subject], too. Teacher sometimes gives responsibilities on subject presentation, she arranges the groups, group members conduct research on the subjects and while doing presentation to the class not only s/he learns but also the class learns, as well. (S1, 4th Grader, Public School A)

> We are discussing into three or four-student groups and sometimes we are learning about our foreknowledge with regards to the new topic (…) We are discussing the subject sometimes in groups, and sometimes individually. (S46, 5th Grader, Private School B)

The data analysis also revealed that sharing interesting information in the classroom addressed to the students` social integrative needs. As illustration, S1 believed that when she shared something in the classroom that her friends had not heard before, her teacher admired her, and she felt valuable. She elaborated on this as follows:

> When our parents taught us something related to science, we share this in the class. I participate to the lessons and present it [science information] and it takes interest. (S12, 4th Grader, Public School B)

Sharing interesting information seemed to take part in the teaching and learning process in the private schools in a slightly different way. In Private School B, the students introduced an activity called: "Free Bench" (Serbest Kürsü) in which they shared a new topic-subject with each other. With this activity, they had a chance to make presentation about their favorite science topics and share it with all students in the school. The analysis of the transcribed interviews conducted with the students indicated that this way of sharing addressed the students` cognitive needs (acquiring information), personal integrative needs (gaining status), and social integrative needs (contacting with friends, teachers). To illustrate this, S46 (5th Grader, Private School B) said:

> There is a bench on the 5th grader`s corridor. In any time [during breaks] any of us goes up to the rostrum and if you would like to listen [to the discussion] you listen to it. Nobody intervenes him/her [one who is sharing the information]and they [students] defend their ideas (…) It mainly happens in break times and it is short, not boring. Anyone can share his/her ideas on Free Bench.

Hands on experiments were also among the highlighted topics by students characterizing learning science process in class. 3D materials, exhibitions, and experiments were found to take the students` attention. Laboratory experiments were mainly emphasized by private school students as a contributor to their science learning (both public schools did not have any science labs) as well. The focus group participants in private schools generally agreed that doing experiments and watching videos, cartoons, and documentaries were effective in their science learning while making science more permanent in their minds. The following quotations are related to the students` views on science experiments and videos/cartoons in their science learning:

> Science information becomes permanent through the cartoons we watched and (…) science experiments we did. (S43, 5th Grader, Private School B)

> Once, she [teacher] brought a volumetric flask to the class and we did experiment with it. I was so excited that I waited impatiently to try on the experiment. She added some water on it and then brewed it (S20, 4th Grader, Private School B)

Educational software products were found to be mainly used at the beginning and end of the science classes in public schools. According to T6, these software programs provided authentic experiences for students with visual and audio content. To illustrate, one student said:

> There are some things [software] like Morpa Kampüs. They are explaining the things visually with animated figures and I learn it [science] better with them (S36, 5th Grader, Public School B).

For one of the teachers (T8), educational videos were advantageous as he had the opportunity to stop the program to discuss something when necessary. In some classes, the teachers got the students to take notes from Morpa Kampüs, and asked questions about the topics showed in measuring students` understanding of the new concepts and learnings. Students also responded to the questions in softwares like "slaytyerim.com, slaytizle.com". Interestingly, in one of the classrooms, students and the teacher expressed that they sometimes played games while they were watching a video called "Attention, Attention!" (Dikkat, Dikkat!). Before the game, the teacher informed the students that they would play this game and gain their attention accordingly. During the video, she stopped the video and asked the students the meanings of the things they watched. The teacher and students agreed that this game made the videos more enjoyable in learning science.

The teachers also used science books apart from textbooks in the science classes. They prepared handouts for students and sometimes got the students to take notes from the science books. Private School B teachers explained that they brought various science books for each chapter and during the chapter, students also examined these books in class to gain further information in relation to the science topics as also summarized in Figure 4.8.

In addition to the sources aforementioned, student workbooks also supported students` use of textbooks with various close-ended, open-ended, and fill-in-the-blank questions during the science classes. As explained by S1 (4th Grader, Public School A), students used workbooks to do the activities and to revise the subjects they already covered in the textbook.

4.2.3. SIS Used for Exam/Test Preparation

The analysis of the transcribed interviews revealed that the students preferred specific SIS for exam/test preparation. The students stated that they studied from their textbooks and the other science books to acquire in-depth information about the subjects when they had exams as the pictures and colorful figures in the science books were attractive for children. Moreover, it was found that the students used science books to solve tests in preparation for national exams which addressed to the satisfaction of their cognitive needs (learning various new things). Families were the other mostly used references to apply for as shown in Figure 4.9.

In exam preparation, the students also reported using their notebooks with a combination of textbooks and science books since their teachers had them to take notes from both books. In addition to this, the students applied for their parents and asked questions or studied with them while they were studying for the exams / tests. To illustrate some of the students stated:

> I ask math questions to my father because my father studied math at the university. Therefore I receive support from my father and without wishing to boast I get 100/100 in the exams. (S25, 5th Grader, Public School A)

> (…) My mother is a biology teacher and she helps me with the complex topics. We study for the exams together. (S17, 4th Grader, Private School A)

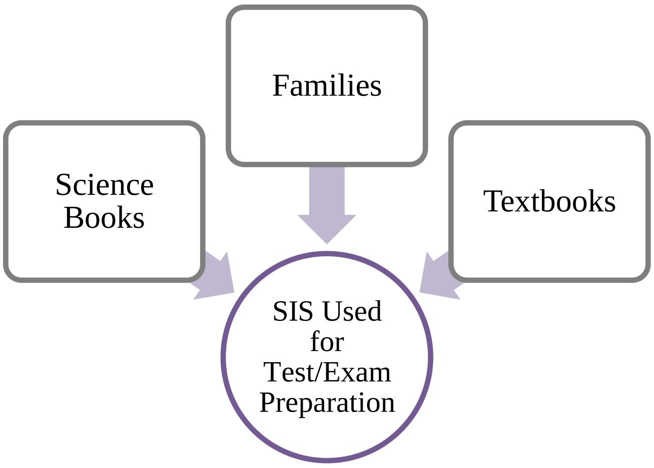

Figure 4.9. SIS used for test/exam preparation.

Complementing the findings emerged through the analysis of the observations, the interviews conducted with some students and teachers revealed that students read and took notes from the science books while they were studying for the exams or tests. By way of illustration, S16 (4th Grader, Private School A) said:

> I have a book [science book]. We bought this when I got lower grades in science. It includes CDs, games, two additional books. When I study

> [science] using these, I become more successful in science and technology. (…) I enjoy [learning science] with these books.

Another SIS used for test preparation was suggested as educational software products by one of the parents. P3 asserted that her child used educational software like Vitamin and Zambak when she had exams.

4.2.4. SIS Used for Conducting Individual Science-Related Research

It is important to note that the students were interested in subjects like space, animals, robots, and human body. Except for the robots, these subjects were part of the school science curriculum and in most cases students were selective on accessing information about these topics. Students processed further research to meet their cognitive (learning further information), affective (being interested in the subjects they liked), personal integrative (having status, confidence), and social integrative needs (contacting with class, family, and the others). The data analysis revealed that most of the students did not conduct research with regard to their topic of interests. Instead, they stated that they did research only if they had a project or homework. Parents and teachers` interviews also confirmed that most of the students did not conduct individual research apart from their school science requirements.

Apart from this, several students explained that the students were willing to conduct research on their favorite science topics. Interview analysis resulted that these students mainly used internet, science books (other than textbook), and science magazines as well as consulting to their parents with regard to their interests as illustrated in Figure 4.10.

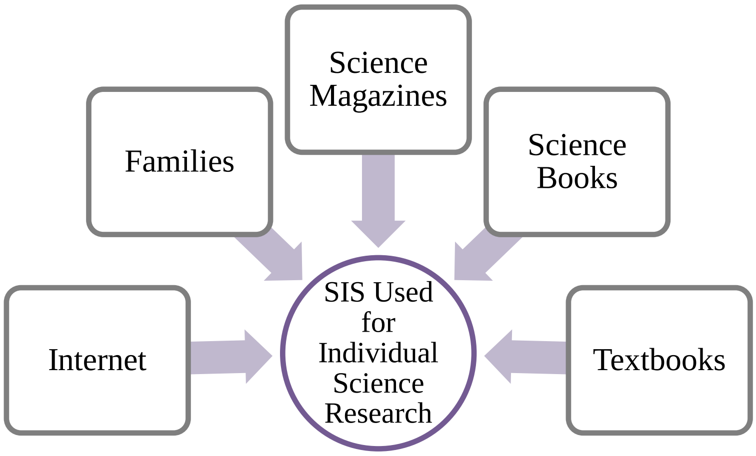

Figure 4.10. SIS used for individual science related research.

The internet seemed to be one step ahead among the other SIS in terms of enabling the students to conduct individual research. The teachers agreed that the students` main source for their random science questions was the internet. However, according to the teacher interviews, when the students had school science specific questions, it was common for them to ask their teachers instead of searching it on the internet. Below are some representative quotes:

> I am interested in the universes. I have some files on the desktop and I compile the documents related to science in the folders. In addition, I mainly like science pages on Facebook. (S31, 5th Grader, Public School B).

> I am interested in DNA. It is very interesting for me because our codes are hidden inside this (…) I conduct research on this by using the internet and science books. I ask to my mom, as well. (S44, 5th Grader, Private School B)

> I am interested in planets. I find some information from science books, science magazines. If I cannot find it there, I ask it to my parents and if they cannot either I search it from the internet. (S10, 4th Grader, Public School B)

The need for satisfying the personal and social integrative needs was found to be one of the reasons that encouraged the students to use SIS for individual research. The analysis of the transcribed interviews revealed that the students shared interesting things in their class environments which satisfied their personal and social integrative needs. Moreover, some of the students said that they collected the magazines with their additions which they found useful in learning science. Some of them also cut the pictures and/or texts in these magazines and pinned them to their rooms or stuck them on their personal notebooks. To demonstrate, two students said:

> I cut the texts of critical sections [from science magazines]. I have a notebook. I stick these pieces on this notebook and it becomes like an encyclopedia. (S25, 5th Grader, Public School A)

> I read science magazines. In “Bilim Çocuk” (Science and the Child) there is a section called “Ne Var Ne Yok” (What is There, What isn`t?) and I cut and stick some pictures on my cupboard so that I will be able to see them over there. (S29, 5th Grader, Public School A)

In the interviews conducted with the students, the students were asked to imagine that they were well-known scientists and discovered remarkable things in their field of study. Based on this contextual input, they were further asked how they would like to share their findings with other people to inform them. The analysis of the transcribed interviews revealed that all students were eager to share their scientific findings with the other people. In other words, students were found to be enthusiastic about communicating science information. When it comes to the channel of conveying that specific information, students explained that they would choose TV, newspapers, magazines, and internet in order to communicate their findings as these were more common and accessible sources that could reach a wide array of people, as well.

With a different perspective to the issue, this desire to share the findings with people was found to be related wth the students` personal (gaining prestige, high standing) and social integrative needs (contacting with people). To illustrate, some students said:

> I would like to share [my scientific findings] with other people, and I think the most effective way is newspapers for this. Because older people and some of the adults are not internet users. Mostly young people [use the internet]…And some of the young people may not care about these findings. Thus, I would use the newspapers. (S46, 5th Grader, Private School B)

> I absolutely would like to inform people about my scientific findings. In order to do this, I would choose the internet because science

> information on the internet updates itself everyday. Everyday, almost everybody uses the internet (S44, 5th Grader, Private School B)

> Yes, I would. [like to share my scientific findings]. I would like to prove it while publishing it on internet, newspaper, or TV because there are quite a few people who watch TV, or who read newspapers. Internet has 26 billion users, in just Türkiye. Therefore, I would like to share my findings through mostly used sources. (S45, 5th Grader, Private School B).

> Newspaper, TV, and internet. Newspapers, because older people use newspapers. Internet is for youngsters. TV is for people who do not have internet access or who cannot use internet. (S12, 4th Grader, Public School B)

Table 4.1 displays a summary of students` uses and processes of sources in learning science.

Table 4.1.

Sources that are in Students` Use in Different Contexts

USES OF SIS / **SIS**	Sources that Students Use Frequently in Their Daily Life Both for Science and Not Science	SIS Mostly Used in School-Based Contexts		SIS Mostly Used in School Beyond	SIS Used During Science Classes	SIS Used for Doing Homework/ Project Requirements	SIS Used to Conduct Individual Science-Related Research	SIS Used for Exam/Test Preparation
		Public School	*Private School*					
TV	√			√				
Science Magazines	√			√			√	
Newspapers				√				
Internet	√			√		√	√	
Family	√			√		√		√
Teachers	√	√	√		√			√
Classmates	√		√		√			
Textbooks	√	√			√	√		√
Science Books			√	√	√		√	√
Educational Software		√			√			
Science Centers/ Museums				√				
Science Exhibitions				√				
Science Camps				√				

Note. SIS: Science Information Sources. SIS use indicated differences among school types (public and private schools) specifically in school-based contexts.

4.3. Effective and Ineffective Features and Uses of SIS

In this section, effective and ineffective sides of the SIS were assessed in terms of the accessibility of the sources, the quality of the content, and the content presentation. Figure 4.11 illustrates the effective features of the SIS parallel with the content and presentation of the specific content.

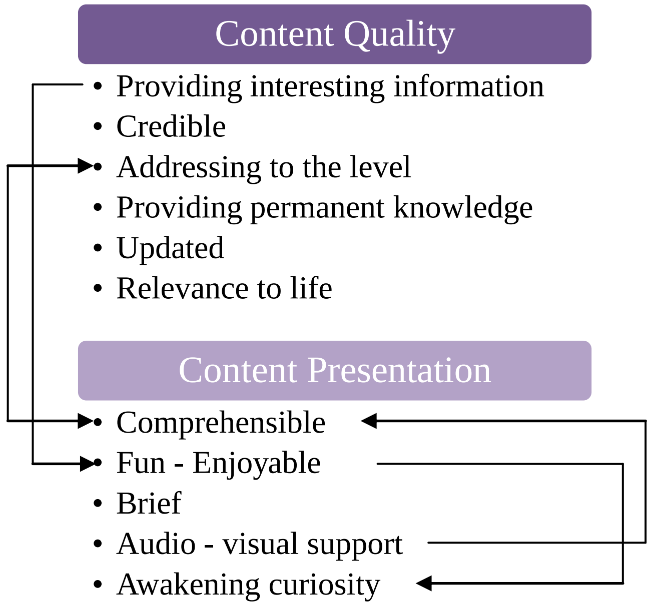

Figure 4.11. Characteristics of an ideal SIS through content and content presentation. *Note.* Arrows indicate the relationship between some of the features.

To begin with, accessibility of the sources was students` priority in choosing and using SIS. Sources stated to be accessible were TV, internet, textbooks, teachers, and families. Next, it was found that students saught for the quality of the content of the SIS.  In line with this, some characteristics that an ideal science information source`s content and content presentation should have were identified. Furthermore, the analysis of the data revealed some connections between the sub-themes. For illustration, as seen in Figure 4.11, sources that provided interesting information (TV, science magazines, and science centers/museums) had entertaining elements and sources including fun and enjoyable elements in the content presentation were found to awaken students` curiosity towards science. Likewise, there was a reciprocal relationship between a source`s addressing to the level and being comprehensible. Below are some quotes that highlight the effective features of SIS regarding the content and presentation of the SIS.

> Firstly, it [science information] should increase *curiosity*, it should be *interesting* in order to not to bore people. Then, it should be presented in a way…a little bit *enjoyable*…because if science information is based on just knowledge, then people cannot make it enjoyable. Afterward, presented science information should be *understandable*. If not, it may cause misunderstandings and misconceptions. (S34, 5th Grader, Public School B) [emphasis added]

> (…) increasing *curiosity*, for instance you learn something and then you wonder about another thing, then you come up with a different thing. In addition to this, science information must be *enjoyable* because people may not want to learn it [science information] anymore if they get bored. (S7, 4th Grader, Public School B) [emphasis added]

In the following parts, effective and ineffective features of the sources were examined in detail under three headings: Accessibility of the sources, content of the sources, and content presentation.

4.3.1. Accessibility of the Source

Participants in this study concurred that accessibility of the sources was one of the chief factors in drawing on the sources. In this study, accessible sources were found to be TV, internet, textbooks, teachers, and families.

In the first place, accessibility was found to be an advantage of the TV as a SIS. According to the interviewees (P3, P6, P8, and T2) access to the TV was quite easy in almost all households and this was one of the reasons why the TV appeared among the most effective science information sources. Here, it is important to note that although the TV was reported to have accessibility feature, some of the students considered program guides as a problem in reaching science related information. They stated that science programs for children were published in the mornings and afternoons while they were in school. That is why, they complained about the difficulty of finding a science related child program whenever they wanted.

Next, internet emerges as an accessible and user-friendly source for students. The analysis of the interviews revealed that as the internet was an accessible source and used by most of the people, it became a place where the students shared/would like to share their science related findings with other people. Giving the priority to the internet, S19 (4th Grader, Private School B) explained that he mainly used internet in his research on science as TV or newspapers did not provide the information he needed when necessary. Likewise, S31 (5th Grader, Private School A) also commented on the accessibility of the internet:

> People used to get information from encyclopedias. But now, they just use the search engine and access the information, directly. It is easier and it makes the best of one`s time.

Besides its advantages as an accessible source, many teachers criticized the internet for directing students to expect everything to be handed to one on a silver platter. T4 complained that students even did not read the things they accessed through internet. Therefore, teachers and parents suggested that students needed maturity and guidance about internet use regarding especially which sites to visit, what information to trust, and how much information to get.

Teachers and families were other accessible SIS for students. Mentioning about accessibility of their family, some of the students stated that they mostly did not have a chance to ask questions to their teachers during the science classes but they would ask most of the questions they had to their parents whenever they needed.

Textbooks which were distributed to all schools by the MoNE were found to be accessible sources, as well. In other words, textbooks were like a common ground for each student. Considering this, T2 preferred that textbooks should be arranged and written meticulously as some children had no opportunity to reach science from the other sources. She also added that unlike the textbooks, science books were not accessible for all children.

The analysis of the data revealed that science centers/museums and science camps held some limitations in terms of accessibility. Criticizing science centers/museums for its accessibility, S42 and S44 (5th Graders, Private School B) argued that more guidance should be presented in the centers/museums in order to enable students to learn something from the exhibits. Underlying another limitation of the science museums, S19 (4^{th} Grader, Private School B) said that he needed someone with him to visit the museums; therefore, he could not visit there as he wished to be. In line with what the students said, several parents and teachers (T2, T8, P3, and P10) stated that science centers and museums were not accessible. As it was hard to visit science centers/museums whenever they wanted, some of the students thought that they should apply for the other sources to learn science as seen in the following quote:

> I rarely visit the museums. I generally learn the things I need until I go and visit a museum. (S33, 5^{th} Grader, Public School B)

Likewise, some students stated that they did not get any chance to participate in science camps because the camps took place during summer time while they were in holiday. Many 4^{th} graders added that they would not be able participate in science camps until the following year because of the age restrictions in especially TÜBİTAK science camps which are eligible for students starting from 5^{th} grades. Talking about the long procedures to apply and participation criteria, T2 advocated that science camps were not practical as a SIS in comparison to the other sources. For some of the teachers, an effective SIS should be economical and accessible. But, science camps did not match with these two criteria. Here, it is important to note that announcements of the science camps were not made as required. Most of the parents and teachers complained that they were not provided sufficient information on the science camps. To illustrate, one of the 4^{th} grader`s mother commented as follows:

> Once a time, she [her child] mentioned about a camp in İstanbul which was very expensive. I do not know much about what is happening. There is no one to guide us, too. You want to learn science but it is not clear where or whom to apply for.

Parallel with this, T13, as a private school teacher, explained that students were all interested in participating science camps but family opportunities were also determinative in students` choices. Most of the parents were working and camps were held mainly in summer time when families went to holiday, which made science camps ineffective in terms of accessibility.

4.3.2. Content of the Source

The content of the sources was another determiner in students` using the SIS. As seen in Figure 4.11, presenting interesting and trustworthy topics which address to the level, providing permanent and updated information in the content, and holding relevance to real life were the key elements in students` preferences and uses of the SIS.

Content of the TV as a SIS

The analysis of the interviews conducted with students revealed that content of the TV was effective in terms of presenting authentic, updated, and interesting information which might be repeatable as the programs were recordable and might be watched again. The interviews carried out with parents were found to be consistent with what students asserted about the content of the TV. By way of illustration, P9 said that TV was effective in her child`s science learning because TV was inside the life. In the same vein, S38 (5th Grader, Private School A) commented as follows:

> It [science on TV] is *permanent* because [on TV] *real* things happen there [on TV]. I find it *interesting* and sometimes *fun*. [emphasis added]

The analysis of the interviews further revealed that students disapproved TV as it did not address to their levels. Some of the students claimed that it was not such important to use the TV in learning science as it was fairly difficult to see scientists on TV and there was little science information on TV. Below are some representative quotes:

> *I don`t use TV much for science learning purposes.* On the TV, in general, I hardly see scientists but mostly other people speaking. (S5, 4th Grader, Public School A) [emphasis added]

> I have difficulty in finding science related programs on the TV. That is why, *I do not use TV* [in learning science]. (S19, 4th Grader, Private School B) [emphasis added]

Apart from all these, TV was reported to have distracting elements which led to time loss. It is important to note that students mostly believed that TV watching took too much time. To illustrate, S23 said:

> There are too much cartoons [instead of science programs] on TV. When you start to watch [it] you cannot keep yourself away [from watching it].

TV, as a mass media source, was for people of all ages. Thus, students also criticized TV for the content of the programs which mainly did not specifically address to students` levels. However, TV was praised for being an updated source which presented interesting science information related to real life.

Content of Magazines as a SIS

By means of science magazines, students emphasized that they learned many different topics which were interesting and sometimes complementary to the things they learnt in school. Supporting this, P6 and P9 explained that when they bought "Science and the Child", their children wanted to read the whole magazine and did not want to leave it without reading it all. Based on her observations, T2 stated that science magazines took students` interest. Similarly, T3 also asserted that science magazines complemented the school science subjects.

The analysis of the interviews conducted with the students, teachers, and parents further revealed that science magazines presented quality and trustable knowledge while addressing to children`s level, and it was easy to keep in mind the things learnt from science magazines. In other words, the content of science magazines constituted permanent knowledge in students` minds. Most of the students explained that they found the topics covered by science magazines very interesting and enjoyed reading them while learning something new. Therefore, they commented that science information they learnt from science magazines was permanent in their minds. To illustrate, two students stated that:

> It [science magazine] is very *enjoyable* and you learn various different things. It *addresses to your level* and you may understand it better. Thus, this makes the information *permanent* in your mind. (S5, 4^{th} Grader, Public School A). [emphasis added]

> I think it [science magazine] is really *fun* because it is for us. It *addresses to us* as S42 said. Like its name: "Science and the Child"… It is understandable, we are having *fun* and therefore it becomes *permanent* in

> our minds. It also *increases the curiosity* towards science and there are many experiments which I would like to try, as well. (S45, 5th Grader, Private School B) [emphasis added]

It was also contended by some of the parents and teachers that as science magazines addressed to the levels of the students, they felt special. One of the parents (P6) commented on his child`s interest in science magazines: “He loves it because he feels special with this magazine. It is something for children.”

Unlike the content of the TV, there were not many drawbacks identified about the content of the science magazines. Outstandingly, one of the 4th grade students from Private School B complained about science magazines` having too much animal content.

<u>Content of Newspapers as a SIS</u>

Content of the newspapers was reported to be one of the reasons why students preferred and used newspapers as SIS. When students assessed the features of newspapers in learning science, they agreed that science information in newspapers was updated, trustable, and interesting. They added that they learnt different things in newspapers as different from their school science curriculum. In line with this, teachers and parents stated that news in the newspapers provided reliable science information for students. As a matter of fact, compared to the internet, information in newspapers was defined as more trustworthy by the students. Newspapers were also identified as updated sources. By way of illustration, S45 (5th Grader, Private School B) stated that:

> Newspaper *updates* itself everyday. I learn *recent science related news* from the newspapers. It is also *more trustable* than internet. That is why, I prefer newspapers. [emphasis added]

However, when students compared science magazines and newspapers, they made preference over the science magazines since magazines addressed to their level. The analysis of the data revealed that students did not have a newspaper reading habit yet. However, students and teachers confirmed that some parents informed their children about interesting news they came across in the newspapers.

Apart from not addressing the level of the students, newspapers were reported to include insufficient science. Instead, the newspapers were indicated to center on politics, economy, magazine, and detective news. Interestingly, S16 (4th Grader, Private School A) maintained that news on the newspapers was also available on the TV and she preferred watching TV instead of reading newspaper accordingly. For these reasons, students explained that they did not prefer to read newspapers in learning science. To demonstrate, two students said:

> I do not read newspapers much because there is not much science on the newspaper. The news is all about votes and politics. Thus, I do not read it. (S15, 4th Grader, Private School A)

> There is not much science related news on the newspaper, anymore. Rather than science issues, the news are about murder, voting, and detective. Therefore, I do not read it. (S23, 4th Grader, Private School B)

Consistent with what students said, two parents (P3 and P8) stated that newspapers were full of violent content, third page news or policy which did not address to children anymore. According to P9, newspapers were old-fashioned and one step behind in comparison to internet and TV as these two presented updated information even hour by hour. T16 considered that newspapers sometimes had unreliable information with marketing anxiety. That is why, she did not find newspapers scientific.

<u>Content of Internet as a SIS</u>

Students used internet to access science information since it provided mainly detailed and interesting science information as stated by the following students:

> Internet provides the most *detailed information*. It is the only way for me to access the information I needed. (S25, 5th Grader, Public School A) [emphasis added]

> I think science information on the internet is *understandable* because we may reach every *single detail* and I find it very meaningful to learn something through different angles. (S4, 4th Grader, Public School A) [emphasis added]

What is more, comparing the internet with the TV in learning science, S43 explained that she preferred to use internet instead of the TV since the information she learnt was more memorable for her. She said that:

> I like using internet [in science related research] than TV. Because on TV it says directly, but you search [information] on the internet and I think this [research on internet] is [constitutes] more long lasting [science information than TV does].

Besides its effective features, internet content was also criticized for its credibility and upper-level science information it presented. To begin with, students in this study mentioned that they did not trust all information on the internet and often needed to double check the presented content. Students also explained that they had difficulty in deciding which information they should use, which caused them to think that internet was sometimes a waste of time as explained by the following students:

> I typically do not believe what I find. For example I remember a text which seemed pointless to me. I checked it from the other sites, as well and when I compared them they were handling the subject in the same way. If things are similar in various sites, then I think that it is true and I use it in my homework. (S24, 4th Grader, Private School B)

> When I access the information from the internet, I always check it out whether it is true or not. I ask it to other people, my teacher. (S41, 5th Grader, Private School A)

> I want to talk about the degree of reliability of the information presented by the internet. I think it is 20%. Most of the topics had people`s comments on them. Merely, 25% of the information is reliable and useful. (S42, 5th Grader, Private School B)

> It sometimes takes too much time to find reliable information which address to our age. Therefore, I think researching from the internet is just a waste of time. (S46, 5th Grader, Private School B)

As a matter of fact, reliability of the information presented by the internet was among the main concerns of the parents and teachers, as well. T6 explained that she warned her students about the content provided by the internet since she believed that internet sometimes included unreliable information in not only scientific subjects but also in general meaning. In a complementary nature, T2 argued about “information pollution” on the internet. Thus, teachers and parents stated that students needed guidance in accessing appropriate science information on the internet. Specifically, utilization of Wikipedia was a controversy among parents, teachers, and students. Some of them thought that Wikipedia presented its content with references; that is why, it was a trustable site. On the other hand, the others criticized Wikipedia since it was an open source with lots of users and everybody had a chance to change the content. In coping with the problems such as validity and authenticity, S21 (4^{th} Grader, Private School B) explained that he used the websites that his family, teachers, or friends suggested.

Family as a SIS in Content Provision

When students were asked about their family as science information sources, they replied that they asked science related questions to their parents because they provided quality, interesting, enjoyable, understandable, and brief science information. Students mostly believed that their parents presented science information very explicitly, addressing to their level. Moreover, learning science from their parents was a comfortable way of learning for some of the students. In this sense, one of the students claimed that:

> First of all we are *more comfortable with our parents* [than teachers]. We may ask more questions and I think it is really *fun.* (S10, 4^{th} Grader, Public School B) [emphasis added]

Furthermore, students also shared the things they had learnt with their parents and discussed the newly acquired knowledge with them. S46 (5^{th} Grader, Private School B) said that she shared the science experiments she did in class with her parents and this made it more permanent in her mind. Complementing this, some of the students explained that when they learned something from their parents, it stayed on their mind and become a part of the permanent knowledge. Some of the students also maintained that their parents provided more permanent information even in comparison to their teachers as claimed by the following students:

> I think it is better when I learn [science] from my parents. In the classroom, the teacher explains [something], you ask questions but you can ask just once. In addition to this, you cannot ask the teacher why it was so. Teacher says because it is. (…) My parents explain the reason of

> this [the answer of the question]. I find this information very interesting. (S8, 4th Grader, Public School B)

> I always study and study on the things my teacher had said and they fly from my mind in the exams or when my parents ask me…but…for example the thing I learn from my mum…I may respond it quickly whenever my teacher asks. (S37, 5th Grader, Private School A)

> It [science information learnt from the parents] is really permanent and it contributes a lot to our participation to the class activities. (S9, 4th Grader, Public School B)

The analysis of the data revealed that although the students regarded their families as an important SIS, teachers complained about parents` guidance. They stated that families sometimes provided children with wrong information, which causes misconceptions. They added that information provided by the families might be high level information which did not address students` levels. T16 explained that this might confuse children in a prejudicial way. In addition to this, T14 explained that they did not prefer their students to ask science related questions to their parents because when parents could not be able to respond students truly, this might cause misconceptions which were difficult to correct for them. Similarly, T2 stressed that it would be better if parents were conscious and they supported their children in their science learning but most of the parents did not.

In brief, families provided permanent and to the level science information through human-human interaction, and students felt comfortable in asking science related questions to their families. Though, some barriers reported like causing misconceptions, busy parents who have no time even to answer science related questions, and siblings` not addressing to the level.

<u>Teachers as a SIS in Content Provision</u>

The analysis of the interviews conducted with the students and parents showed that students regarded their teachers as SIS. They maintained that their teachers presented quality, interesting, and enjoyable information which was appropriate to their levels. To demonstrate, S35 (5th Grader, Public School B) said that:

> My teacher helps me most [in my science learning]. She gives *understandable* science information. She does really *take my interest* through the things she explained, the illustrations she gave, and the experiments she did. It is *interesting and fun*. It definitely *increases my curiosity* towards science. [emphasis added]

S1`s (4th Grader, Public School A) explanation verified that the teachers provided the students with “to the level” science information:

> Firstly, she [the teacher] gathers the high-level information in her mind, then, she presents this content while thinking about our levels.

Similar to S1, 5th grade students S43 and S42 from Private School B also agreed that their teachers addressed their levels. For instance, S42 said: “She converts her 25-age knowledge to our 10-age level.”

P1 commented that if a child believed someone or something was trustable as an information source, it became effective for the child. Therefore, her teacher was effective for his child`s science learning. Similarly, P9 admitted that her child liked the science course most, because he loved his science teacher. In line with this, P10 believed that teachers were critical and effective science information sources in children`s developing love to science. It is important to note that some of the teachers and parents were in agreement that teachers should keep up with the times while updating themselves through the changes in science and technology. The participants did not report any ineffective content characteristics with regard to the teachers.

Classmates as a SIS in Content Provision

Teachers compromised that peer learning was important and motivating for students since they learned the things in a more comfortable way while addressing to each other`s levels. S20 and S21 talked about one of their friends in the classroom who was influential in their developing interest to science. To illustrate, S20 (4th Grader, Private School B) said that:

> We have a friend named “Kemal” [pseudonym] in the classroom and he is interested in science. The science experiments he did and brought to the

> class took my interest. I was very curious and I listened enthusiastically what he talked and showed to us. Thanks to Kemal, my curiosity to science topics increased.

Comparing himself as a parent with his child`s classmates, P7 viewed that classmates were more effective than parents as children might learn best in an environment in which they had their peers in it. In the same vein, T13 advocated that students learned better when they interacted with each other. Therefore, most of the teachers organized the requirements in a way to give a chance to students to collaborate with each other. According to the in-class observations and interviews, students studied in-groups to prepare presentations to meet their homework-project requirements. Especially, in private schools, students were also encouraged to bring various materials to the science classes, express their opinions, and discuss about the concepts.

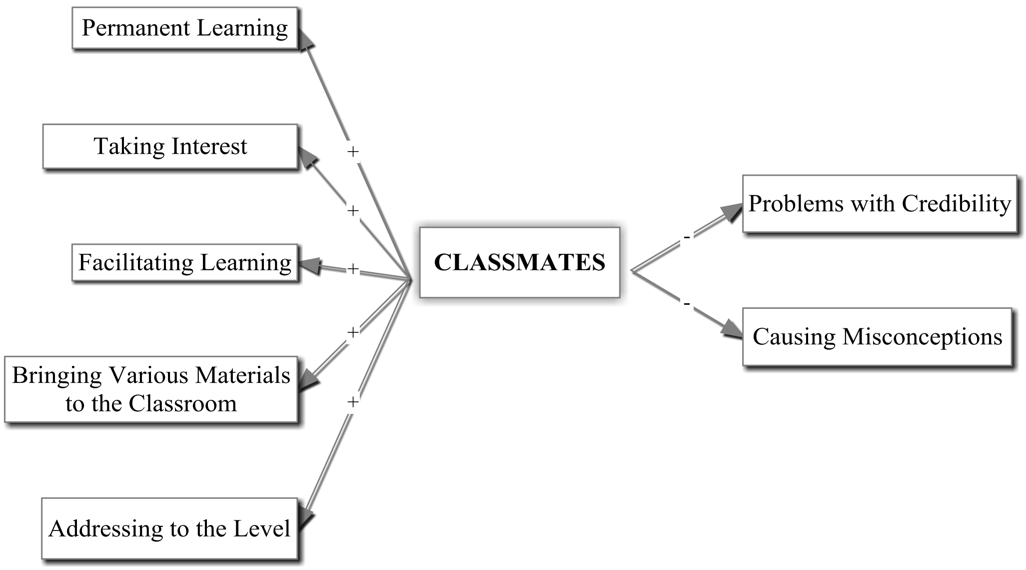

Figure 4.12. Effective and ineffective features and uses of classmates as SIS.

On the other hand, analysis of the teacher interview demonstrated that there were some problems in terms of credibility among students` scientific sharings. The teachers claimed that students might cause misconceptions among each other if they did not know the subject well as illustrated in Figure 4.12. Parallel with what the teachers said, S6 thought that classmates could not be an effective science information source as they were not experienced and they did not have sufficient information compared to the teachers. This also illustrates the general student opinion that students did not focus a lot on what their peers said as they believed that teachers knew more than them.

Content of Textbooks as a SIS

The interview analysis indicated that textbooks presented to the level and interesting science information which constituted permanent knowledge. Students thought that textbooks combined the information from a variety of sources and directed them to the other sources like internet and science books in doing further research. Students also explained that they liked doing experiments and activities from the textbooks even at home when possible. Especially, a section named "Information Drop" (Bilgi Damlası) in their textbook was highlighted many times by the students. They explained that they learned various interesting science information in this part, which was catchy for them. Some representative quotes are:

> I think the textbook provide quality information because it is a combination of many sources and it is hard for textbooks to fabricate information (S4, 4th Grader, Public School A).

> There is a section named: "Information Drop". It covers various interesting information. For instance, cheetah can run faster than any other animals. This takes our interest and we search more it on the internet. (S9, 4th Grader, Public School B).

Besides its effective content features, teachers and parents complained that they came across misinformation in the textbooks several times. Likewise, that the analysis of the interview conducted with them revealed that there existed problems regarding credibility in the textbooks. To demonstrate, one student said:

> My mother is a teacher. She also says so [credibility problems with textbooks]. In textbooks, sometimes there is wrong/unreliable information and I do not like this. One who has started school recently may learn the things wrongly. Therefore, I cannot say I read textbooks much. Let`s say, just for school purposes. S27 (5th Grader, Public School A)

Apart from this, P2, P8, P9, and P10 commented that textbooks were not effective in their children`s science learning as the textbooks had limited and insufficient information and it could not be an adequate main source accordingly. This was an issue for the students, as well. To illustrate, one student stated that:

> Sometimes, I think the information is not enough. For instance, in the section named: “Let`s Know Matter”, there was no information in relation to the density. While we are studying in groups, I do not use the textbook anymore. (…) It is not good to have enough information. As my friends said sometimes there might be unreliable information, sometimes very detailed or insufficient information [in the textbooks]. (S26, 5th Grader, Public School A)

T13 claimed that students were already aware of the limited information in the textbooks, and therefore textbooks were not students` primary source in science learning. P10 illustrated that textbooks might be used in a more effective way when it was used in a group study. Except from this, textbook was not used much and it was nothing than just a piece of material that was carried out from school to home when there was homework. P9 shared that her child hardly ever brought his textbook to home and she commented that her child did not find textbook interesting as it had insufficient content. P2`s description on his child`s usage of textbook in learning science is below:

> I think they feel like it is already under their hands. As they find textbooks inadequate, they use other sources like internet, science magazines, and encyclopedias.

Most of the teachers complained about the excess of units, unnecessarily long information, and some repeating activities in the textbooks. According to the teachers, textbooks should be revised and the units and subjects should be eliminated considering time limitations. Specifically, T5 claimed that since there were several chapters, it was not possible to do scientific sharing or research which she thought was very important in science learning.

P8 suggested using textbooks with supplementary CDs as she believed that current textbook content was inadequate. T9 came up with a different suggestion. He believed that it would be better if textbooks were printed in a more quality way with attractive, colorful visuals on it as he found textbooks boring as a teacher and he was sure that children thought similarly.

To summarize, besides its effective features such as bringing a variety of science information together, presenting to the level science information and forming permanent science information, textbooks also had some ineffective sides like containing inadequate information and held the problem of credibility.

Content of Science Books as a SIS

Content of the science books was found to be among the reasons why students used the science books as a SIS. The analysis of the interviews revealed that content in the science books addressed the students` levels through quality and interesting science information. For students, science information they accessed through science books constituted permanent science information. It is important to note that interviewees did not put forward any drawbacks in relation to the content of science books. Exceptionally, T17, who is science laboratory teacher and the head of Science Department in Private School B, stated that as teachers they made use of different books for science courses in instruction after examining all these books in detail. She added that some books caused misconceptions through picturing or narrating gender roles in a prejudiced way such as a mother cooking dinner with her daughter and a father watching TV with his son. She agreed that science books were necessity in supporting the classes but she suggested that educators and parents should be very conscious in selecting books for the students. All in all, science books as a SIS were found to present interesting and to the level science information which formed memorable science knowledge. However, they were also criticized for bringing about misconceptions like identified gender figures in some cases.

Content of Science Centers/Museums as a SIS

Science in science museums/centers provided quality, interesting, credible, and re-collective learning environments through three dimensional, touchable exhibits. To illustrate, one student said:

> (…) The information in science centers/museums has high quality and trustable…and, it is very enjoyable and memorable information since we see, touch, experiment, and try. (S3, 4th Grader, Public School A)

In relation to the ineffective features of the science content provided by science centers/museums, some students explained that it was sometimes difficult to understand the content provided in the centers/museums since it addressed all people from all ages while one of the students thought that they visited science centers just to have fun not for science learning purposes.

What is more, P3 asserted that science centers and museums did not update themselves, that is why when her child visited a museum/center for a second time, it seemed like this museum/center had completed its mission and it did not have much more impact on her child compared to their previous visit.

Content of Science Exhibitions as a SIS

Science exhibitions emerged as the next effective SIS in terms of providing students with permanent, interesting, and comprehensible science information as illustrated in Figure 4.13 below.

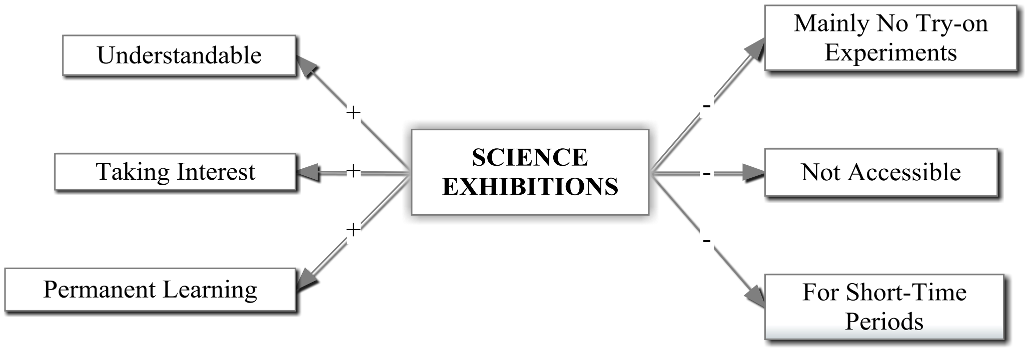

Figure 4.13. Effective and ineffective features and uses of science exhibitions as SIS.

Another effective side of the science exhibitions put forward by the students was that they felt excited about what they had seen in the science experiments during those visits. Some representative quotes are:

> When I was young, in kindergarten, I went to a science exhibition with my school. It was unbelievable and amazing! In these ages, I even would not know about what an exhibition or a museum meant but that guy [Leonardo da Vinci] has invented incredible things. (S21, 4th Grader, Private School B)

> I find it [science exhibitions] interesting because there are many different things even some of which I haven`t seen before are exhibited. It is very good for seeing things with visuals and maquettes. (S8, 4th Grader, Public School B)

Apart from this, S44 (5th Grader, Private School B) compared science exhibitions with science centers/museums:

> The information I learned is much more than [I learned from] museums. (…) You can see the exhibits clearly. In the space exhibition I visited, there were astronaut`s clothes, rocket illustrations. It is [science information gained in science exhibitions] more permanent [in comparison to the museums]

Besides these effective content features (e.g., comprehensibility, interesting, and permanent science information), there was no ineffective feature stated by participants towards science content provided by science exhibitions.

4.3.3. Content Presentation of the Source

In content presentation, introducing the content with fun-enjoyable elements, visuals, in a brief and understandable way were important for students. Furthermore, sources that increased students` curiosity were reported to be effective in students` science learning (see Figure 4.11).

Content Presentation of TV as a SIS

Learning science from the TV was enjoyable for students as the TV presented its content in an audible and visual way. Students claimed that when they watched something on the TV, they felt like they were in the scene they watched. The advantages of visuality of the TV were also highlighted by teachers and parents. In relation to the TV`s audio and visual features, S21 (4th Grader, Private School B) explained that:

> …for instance lunar eclipse, solar eclipse…We already know them but…I have never seen a solar eclipse in my life. I watched this in a documentary and I felt like I`ve seen it. How is it happening? Those kinds of programs do really help [me to learn science].

Similarly, comparing the TV with her textbook on the visuality, S15 commented that:

> (…) in the textbook there is not much authentic pictures about fossils but long texts. That is why textbooks take my interest less. But the TV is both audio and visual and at the same time they [programs] are animated which is really interesting. (4th Grader, Private School A)

Remarkably, S42 (5th Grader, Private School B) emphasized the place of visual elements in science since he thought that science was difficult to describe. In line with this, illustrations and other visual elements seemed to have an important role in students` science learning.

As summarized in Figure 4.14, the students stated that science on the TV was interesting, easy to understand, and fun. What is more, they explained that they learned different things from science programs on the TV, which increased their curiosity and motivated them to conduct further research. As reported earlier, the TV was a directive source. Some of the students explained that if they would like to learn more about the science issue that they came across on the TV, they used the internet, science books or asked questions to their teachers and families as directed sources in this case. Parallel with this, P6 commented:

> Besides other channels, he [his child] also watches National Geographic and Discovery Channel on the TV. He seems to find it useful. For illustration, if the subject is formation of the universe, it is futile to talk or read about it in comparison to watch a visual documentary from the TV.

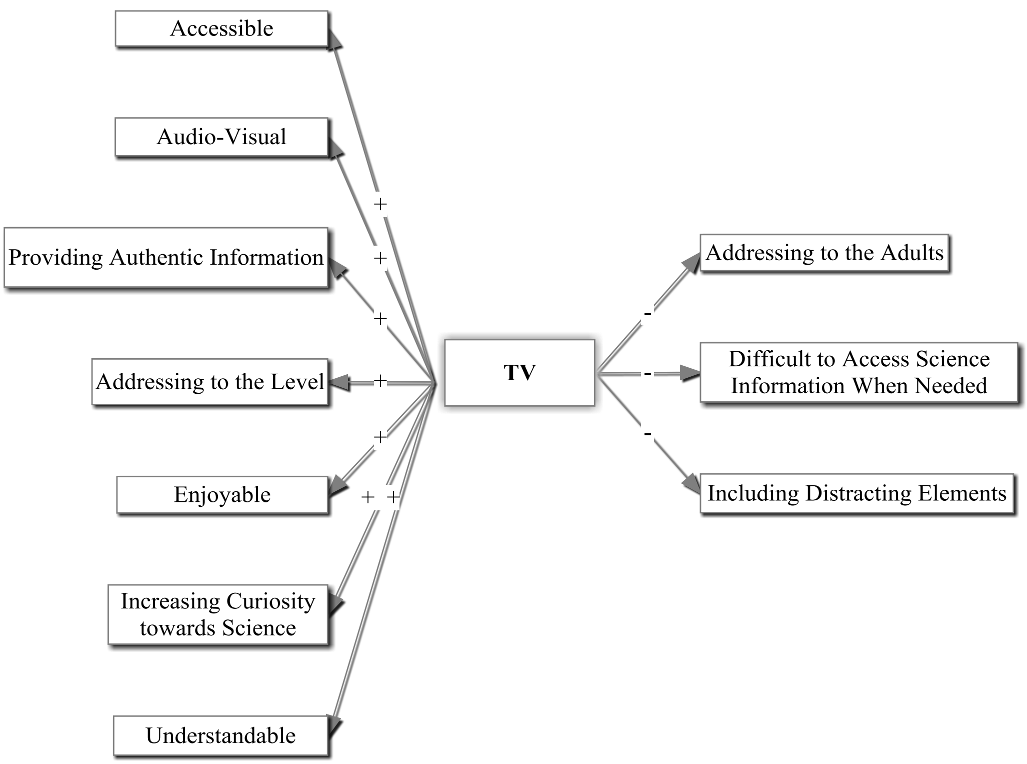

Figure 4.14. Effective and ineffective features and uses of TV as SIS.

Presenting science in a visual and enjoyable way through documentaries and child programs, T2 also believed that science on the TV increased students` curiosity. Moreover, P3 commented that the reason why his child liked watching the TV was its style of presenting the content with fun elements in it. In line with this, for P3, P6, P8, and T2, TV was effective in students` science learning because it was attractive and visual especially when quality programs were selected. However, some programs on the TV were difficult to understand for the students. Presenting the information in a fast way, publishing mainly similar and boring programs which did not take students` interests, and publishing children programs during their school time were among the other drawbacks of TV programs. One of the 4th grade students complained that the information she learned from the TV was temporary. Therefore, it was difficult for her to recite or remember it, which could be regarded as a drawback of the TV. In addition to this, T16 complained about distracting commercials or the other things during a publication which made the TV ineffective in students` science learning. In the same vein, T16 explained that she advised her students about the programs they might follow on the TV:

> I say to them: “We don`t need to follow every single program on the TV. Because if we watch everything, it may both give harm to us and we may not find time to allocate to our homework, families or other sources like books.” In addition, I inform them [students] about which programs to watch on the TV.

This kind of guidance about directing students to the appropriate programs or channels was further discussed in the implications part. Overall, science content presentation on the TV was found to be effective with audio-visual support and enjoyable elements which awakened students` curiosity. Though, the TV sometimes was not comprehensible due to the upper level programs and it had distracting elements like commercials.

Content Presentation of Magazines as a SIS

In relation to the content presentation of the science magazines, students claimed that learning science from the magazines provoked their curiosity. This was also in harmony with what teachers and parents thought about science magazines on students` learning. The students were mainly happy to see many colorful pictures with short and brief texts in science magazines as demonstrated in Figure 4.15.

The analysis of the interviews revealed that students also conducted further research when they learned something interesting from science magazines and would like to learn further. Some of the students explained that they examined their archived magazines with their supplements and some of them cut the pictures and pinned them to their rooms or stuck to their personal notebooks. They also shared the interesting things in class with their classmates and teachers. To illustrate, P6 said that:

> When National Geographic is published, he [his son] immediately reads everything in it. He is like... he doesn`t want to sleep before finishing it [magazine] all.

It is interesting to note that, according to T14, science magazines prevented students` fear of science. Most of the interviewees agreed that science magazines were an enjoyable way of students` learning science. Combining different and interesting science subjects, science magazines had also high printing quality with various visuals on them. T9 expressed that:

> Science magazines may be very attractive for a child after leaving from daily monotone course system.

The analysis of the interviews revealed that certain science magazines were proved to be more useful than the others. T5 explained that she found “Science and the Child” lively for students with many colorful visuals, games, and comics in it. Moreover, the guide was in line with the school units but it provided different perspectives to students. Considering all these advantages of the magazines, T5 explained that she obliged the students to follow this magazine monthly, and she commented that it would be great if this magazine would be a part of school science curriculum as a requirement. Integrating what her friends said about the science magazines, S35 (5^{th} Grader, Public School B) concluded that:

> I think the most convenient example accommodating all these features in it is: “Science and the Child.” Because through this magazine, we do fun

things, learn different things and wonder about them. We feel like we want to buy it again and learn about science more and more.

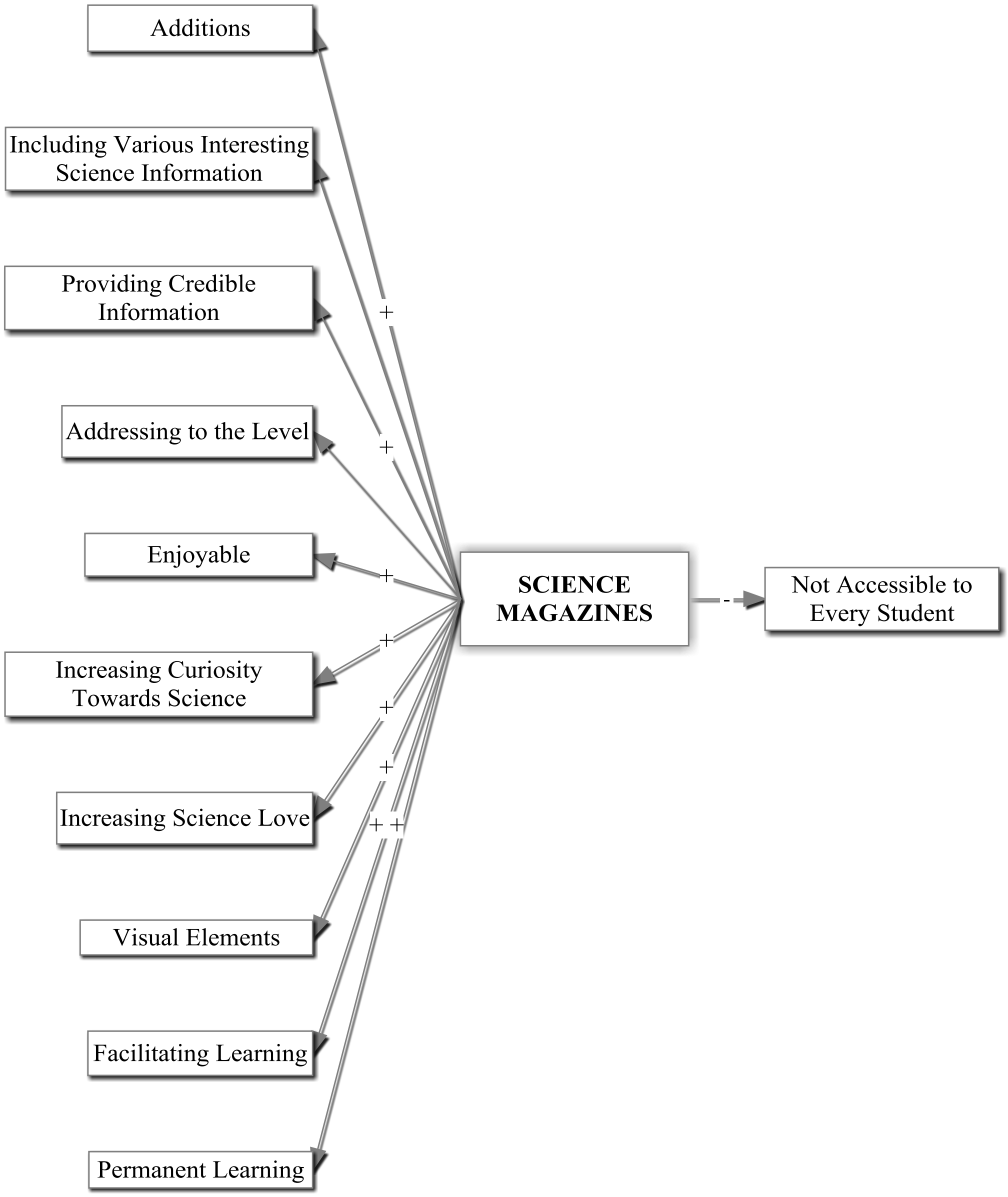

Figure 4.15. Effective and ineffective features and uses of science magazines as SIS.

According to the interviewees, besides effective content presentation features (e.g. comprehensibility, fun-enjoyable, brief, visual support, awakening curiosity) there were not many drawbacks of the content presentation of the science magazines. Exceptionally, some 5th graders from Private School B criticized “National Geographic Kids” for having small text font which made it difficult to understand and boring to follow.

Content Presentation of Newspapers as SIS

Students claimed that since newspapers addressed a wide array of people, it was sometimes difficult for them to understand the science content in the newspapers. Furthermore, newspapers were not enjoyable for students as also demonstrated by Figure 4.16. To illustrate, S1 (4^{th} Grader, Public School A) said:

> Science news in the newspapers is easy to understand, interesting, but some of them are not fun anymore.

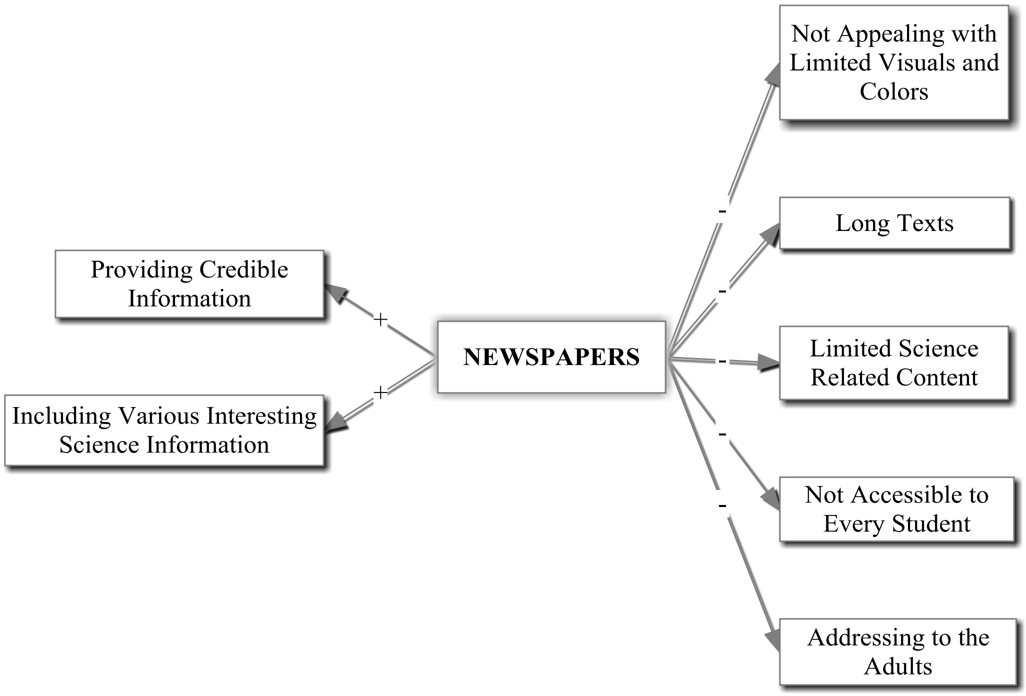

Figure 4.16. Effective and ineffective features and uses of newspapers as SIS.

Newspapers as written sources were not found much effective on students` science learning. T2 regretted that they did not have any reading habit as society and students were also affected by that culture. In coping with this, she explained that she had a subscription to one of the newspapers to share interesting news with her students. She commented on this as follows:

> A few days ago there was an environment related advertisement on the newspaper. I brought the newspaper and shared the news with the

> students. Since I am interested in this news, they are interested, as well. Sometimes they bring and share science-environment related news and they say: “Teacher, I thought that this news may take your interest!” (T2)

Moreover, the parents pointed out that the newspapers did not have colorful, lively pictures like magazines had, that is why, newspapers did not address the students` needs. In the same vein, T5 shared that she did not find science information presented on the newspapers effective.

Overall, as also exemplified by the Figure 4.16, the newspapers were not found to provide effective content presentation characteristics. In fact, newspapers were disapproved of presenting for the content with limited visual support. Moreover, the analysis of the interviews revealed that as newspapers addressed adults, science news in the newspapers was not comprehensible for students.

Content Presentation of Internet as a SIS

The analysis of the interview revealed that the internet had some effective and ineffective features regarding the way content was presented as seen in Figure 4.17. To start with, science information on the internet aroused students` curiosity towards science and directed them to research as stated by the following student:

> It [internet] takes my interest and increases my curiosity. When I learn something, I want to learn more and so I surf on the internet [for more information] and read more [to learn more]. (S17, 4^{th} Grader, Private School A)

Besides its advantages, internet was highly criticized for presenting reduced quality, unnecessarily long, and high level science information. Students mainly complained about the content of the websites which were sometimes complex with vague words and low credibility. The public school students also complained about English words that they came across while they were conducting research. Some of the students highlighted this issue as follows:

> Some of the information I accessed through internet is in English and difficult to understand with unfamiliar words. (…) It is not enjoyable anymore. Reading is fine but when I could not be able to read and

understand these words, it is [accessing science information on internet] getting boring. (S25, 5th Grader, Public School A)

The information provided by the internet is not understandable because internet addresses a wide array of people [not students at their ages]. (S32, 5th Grader, Public School B)

We hardly access to the information on the internet. I need someone who understands them [internet content] and explains in a way I could understand (S3, 4th Grader, Public School A)

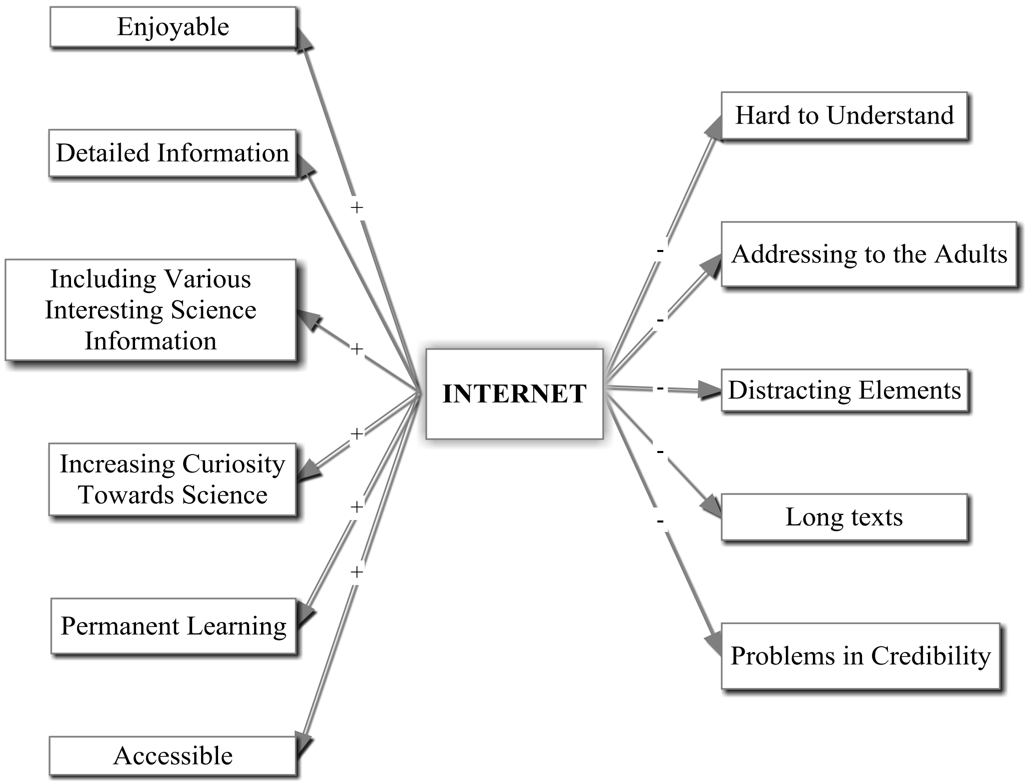

Figure 4.17. Effective and ineffective features and uses of internet as SIS.

What is more, according to the students, long texts with small fonts were another limitation of the internet content. To illustrate, S26 (5th Grader, Public School A) stated that:

When you google something, there comes lots of information that I cannot read anymore. I think this is wrong. Ok, it provides huge information, but who reads all these long texts? Maybe some people do it, but I do not.

In a supportive manner, S14 (4^{th} Grader, Private School A) criticized that some web-sites on the internet had lengthy texts by further stating that "Who wants to read thousands of lines without visual elements?"

Briefly, as summarized by Figure 4.17, content presentation on the internet was enjoyable which awakened students` curiosity. However, the content presentation sometimes included long texts with complex words besides English words.

Families as SIS in Content Presentation

The analysis of interviews conducted with the students and parents revealed that parents facilitated students` science learning. As noted earlier in the chapter, some of the students confessed that they learned science better from their parents in comparison to their teachers as they might ask questions to their parents easily if they had difficulty in understanding and they felt more comfortable in doing so. Emphasizing the importance of human to human interaction S46 (5^{th} Grader, Private School B) stated that:

> Because somebody is explaining you and you can ask promptly if you can`t get it. They [parents] may repeat the things or may explain it [question] through different ways. Sometimes they explain it in a very enjoyable way or through examples.

Furthermore, the students asked their parents to simplify the science information they learned from various sources such as the internet, TV, and books apart from their teachers. To illustrate, one student commented:

> Sometimes I don`t understand the scientific issues on the TV. Then, I ask my mom or dad to explain it in a simple way. They explain me while filtering the information in a way to make me understand it better. Meanwhile, I learn. (S22, 4^{th} Grader, Private School B)

Describing the activities that she did with her child, P8 explained that they visited the exhibitions and museums together with her child. During those visits, her child took photos and some notes to her notebook. She said that when they returned to home, if her child had some questions in terms of the visit, they investigated it on the internet together. Furthermore, P8 added that they collected waste bottles and cups to be used for doing science experiments at home.

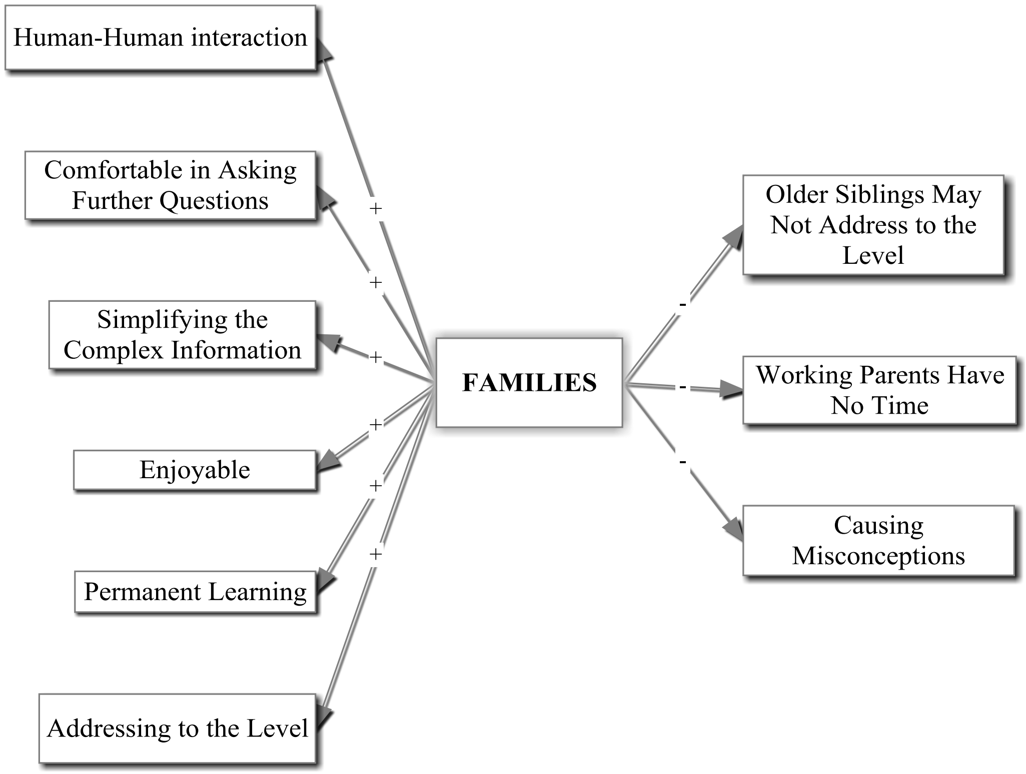

Figure 4.18. Effective and ineffective features and uses of families as SIS.

In private school B, students said that when their teachers gave them science homework to be discussed with their parents, they found it quite beneficial as they were able to get their parents` ideas on the issue. Some parents made science more fun with games or explained the things in an enjoyable, brief, and understandable way which hopefully helped to develop permanent and meaningful knowledge in students` minds as seen in Figure 4.18. In contrast with this, few students in public schools admitted that they had never learnt anything from their parents.

To sum, the analysis of the interviews revealed that the families provided comprehensible, brief, and enjoyable science information while simplifying science information to their children`s levels. With regard to the content presentation, students did not specify any ineffective characteristics of their families.

Teachers as SIS in Content Presentation

In this study, teachers who acted as a meaningful science information source were reported to be those who made science interesting, enjoyable, and understandable by guiding students to access appropriate science information and directing them to the related SIS. Furthermore, hands-on practical activities integrated into the theoretical element of lessons were a mostly appealing component as stated by the following students:

> Science experiments do really work. They make me understand it [science subjects] better (S15, 4th Grader, Private School A)

> When the teacher instructed using experiments, courses become more fun and I understand it [science subjects] better (S14, 4th Grader, Private School A)

Providing important and brief science information, teachers thought that they taught different things that students had not known before. Complementing what their teachers said, the students also stated that their teachers made the subjects comprehensible and facilitated their learning as demonstrated in Figure 4.19. By way of illustration, S39 (5th Grader, Private School A) agreed that she learned most of her science knowledge from her science teacher. Likewise, according to S9 (4th Grader, Public School B) everything she had learned from her teacher was science focused information. S21 (4th Grader, Private School B) reflected on her teacher's classroom teaching practices as follows:

> For example, we wrote some information to our notebook, my teacher wants me to write it with my own sentences while dreaming it and then, to draw it. I mean, she is like she wants to install the information into our brains, [teacher] wants to inscribe it, that is why the knowledge stays in our minds. It [the way] is useful. If our teachers were not [inside the education system], we would not learn these things anymore and we would not be here [4th grade level], we would not be curious about science and technology.

Similar to what the students said about the role of the teachers, T16 agreed that teachers were effective as a science information source for children:

> We [teachers] look into child`s prior knowledge. Then we correct the mistakes if there is any. We understand their level of knowledge. We provide peer learning [opportunities]. In the end, they learn in an interactive environment and teachers are already equipped.

More specifically, T8 asserted that he found “question and answer technique” quite useful in teaching science to students while T3 supported giving cases or examples from daily life while associating the science content with real life in students` learning science. As mentioned before, these illustrations were also emphasized by the students many times. According to the students, science subjects were more understandable when their teachers gave examples in relation to the topic. On the other hand, students concurred that science experiments had a great role in their science learning and they regarded the experiments one of the most effective activities in facilitating science learning and constituting permanent knowledge. Therefore, students thought that experiments were an enjoyable way of learning science. Furthermore, some of the teachers were reported to organize drama activities or word games through the science subjects they covered, which was considered among the interesting activities that facilitated learning science by most of the students as illustrated by Figure 4.19.

Almost all of the private school teachers and some of the public school teachers agreed that, as teachers, they just guided students in their science learning and facilitated their learning while directing them to the other sources. Explaining teachers` responsibilities in students` science learning, T13 put forward that awakening science curiosity, developing students` scientific thinking skills, and letting students produce something played a significant role in students learning science. The teacher believed that this approach automatically directed the students to the other sources. She further commented that:

> Students shape the courses more than teachers. Because when they learnt something, they want to learn more, trying to link something while integrating the parts…They obviously suck all the information from you.

Differentiating human and non-human sources in science learning, T11 mentioned that interactive communication with eye contact and body language was always different from the other ways of communication. As a corollary of these advantages, T11 found that teachers as human sources were effective in students` science learning.

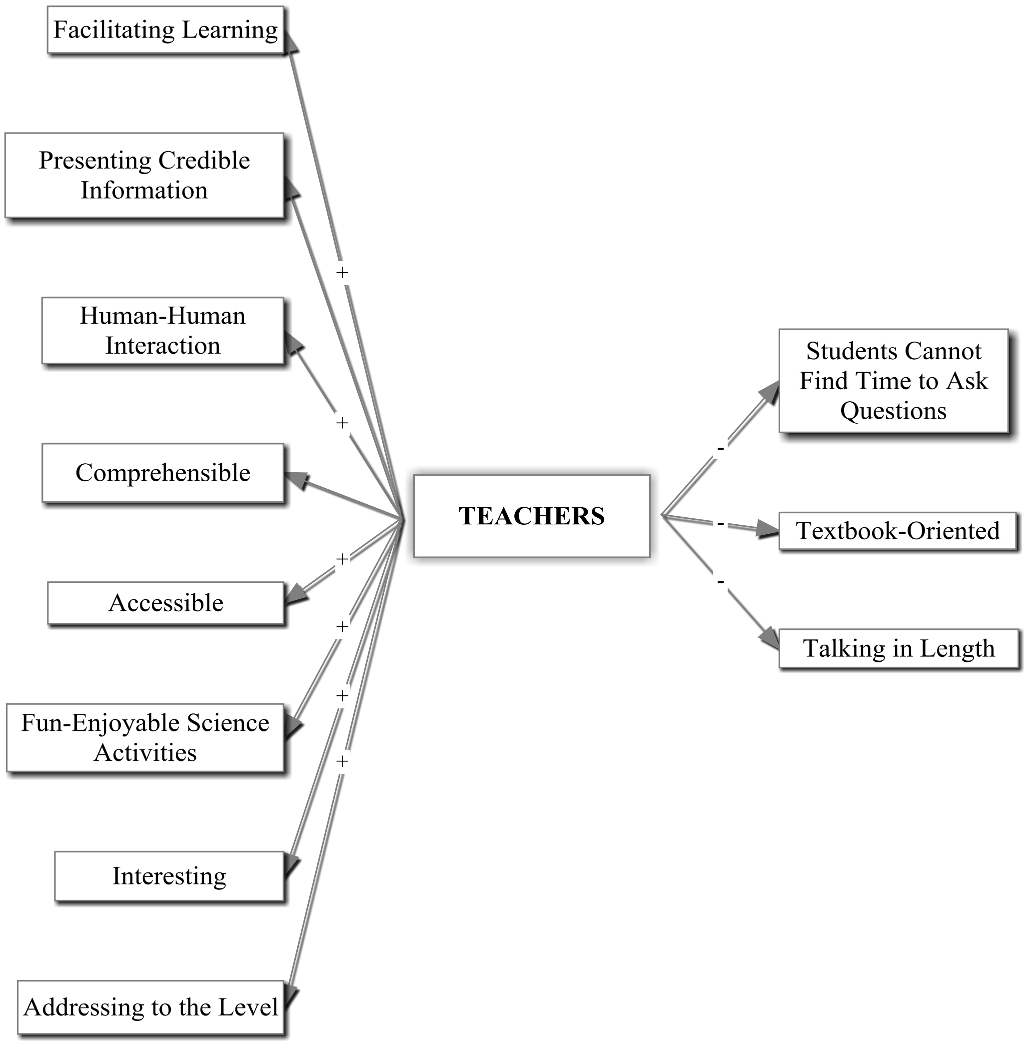

Figure 4.19. Effective and ineffective features and uses of teachers as SIS.

Teachers were also effective in students` preferences of science in their careers. Most of the students considered science related careers in the future. When they were asked about how long they had been thinking about science related jobs, they mainly pointed to the beginning of their science classes in the 4^{th} grade. Having high grades in the science course, having a family member who was professionalized in science, or having fun in science classes were kind of motivation points in choosing science related careers whereas low grades and inappropriate teacher behaviors negatively affected children preferences of science related careers.

When it comes to the ineffective sides of the content presentation, obviously, the teachers in the public schools had more drawbacks than those in private schools from the students` views. For some of the students in Public School A, their teachers did not provide adequate science information for them. They reasoned that they had textbook oriented courses rather than teacher oriented courses. To illustrate, S28 (5th Grader, Public School A) stressed that: “I do think that the course is textbook centered.”

The public school students also criticized their teachers for talking at length about even the same subjects in a boring way as stated by the S9 (4th Grader, Public School B):

> Sometimes I really get bored with my teacher`s instructions, sometimes he really prolongs. It might be explained briefly and it does not make any sense to talk in length on the same topic. We may learn the details by reading. Sometimes I really get bored with my teacher`s instruction (…) He might explain it in a more enjoyable way.

The students further stated that they did not have any chance of talking about their ideas or asking questions while their teachers were talking. Extremely, a couple of students agreed that they got punishment if they wanted to say something while their teacher was lecturing. The students added that they even could not find time to ask their questions to the teacher during a lecture. In line with this, S8 (4th Grader, Public School B) compared teachers and parents as follows:

> I think it is better if parents explain. In the classroom teachers are explaining, you are asking questions but just once. And you can`t ask “why?” She says: “Because it is.” But my family explains the reasons of why which is different from the classroom environments. Parents explain it.

According to the students, teachers` lecturing could have been more enjoyable if teacher sometimes talked about interesting things or the things in an interesting way. The students claimed that when their teachers lectured, nobody listened to their teachers, noise in classroom got increased in a distracting way and as a result of this they preferred PowerPoint slides or videos instead of their teachers. S8 (4th Grader, Public School B) suggested that:

> In the classes, teachers ask and we respond. It should be visa versa (…) I mean, we should ask and teachers should respond.

Criticizing teachers` role in education system while also complaining about teachers` imposing their roles to parents, T6 and P7 stated respectively:

“Education depends on teachers` sense of fairness, or unfairness.” (T6)

“Teachers are the elements who sabotage the education system.” (P7)

Moreover, some of the parents were not happy with the teachers` approach as they thought that the teachers loaded their responsibilities to the parents. P7 asserted that, as parents, they were bored of hearing things like: “Tell this to your parents, let them explain it”. He continued his talk with: “Parents have changed their roles and they have become teachers.” With a different approach to teachers, P3 explained that the teachers did not make sufficient use of the sources other than the textbooks as classrooms were crowded and the teachers had to follow the requirements of the curriculum.

Apart from these, T5 added that science was getting “test-based science” in the 4^{th} and 5^{th} grades and her instruction had to be in line with this: not to increase students` science love, but to prepare them for the approaching exams. She commented on this as follows:

> In their first three years, I tried to arouse their interest in science with field trips, magazines, and the other things I mentioned. But to be honest, especially when they were in their 5^{th} grade, we had to think about exams…What kind of questions come, from which subjects…This was not what I wanted to be but I had to keep pace with it [exams]. (T5)

All in all, the analysis indicated that teachers facilitated students` science learning while simplifying the complex science information and awakening students` curiosity with fun-enjoyable science activities. However, especially students in the public schools complained that they could not have a chance to ask science related questions to their teachers during the science classes and the instruction was chiefly textbook-oriented.

Content Presentation of Textbooks as SIS

The way textbooks presented science to students emerged as one of the reasons why the students preferred and used textbooks. For students, textbooks presented understandable information which addressed their levels as represented by the following quotes:

> Information in the textbooks is easy to understand. It is something prepared for us. There are some enjoyable experiments in it. (S36, 5th Grader, Public School B)

> The things that take my interest in the textbooks are the subjects there. The subjects are really well-covered and easy to understand (S4, 4th Grader, Public School A)

In addition to the textbooks being understandable, science information in the textbooks was reported to be brief and to the point. The students mostly stated that they did not find the presentation of the content complex and over-detailed. To illustrate, one student said:

> Without many details the significant information is given [in the textbooks]. There is various information since they [textbooks] combine many sources and cite from many sources (S5, 4th Grader, Public School A).

Another advantage that was highlighted by the teachers was that textbooks were written based on the curriculum which turned textbooks into main science information sources that supported students` science learning. However, P7 advocated that textbooks were in line with the curriculum but not exams as illustrated by Figure 4.20. According to him, school science curriculum and national exams were highly different from each other, and textbooks should also have addressed to exam requirements.

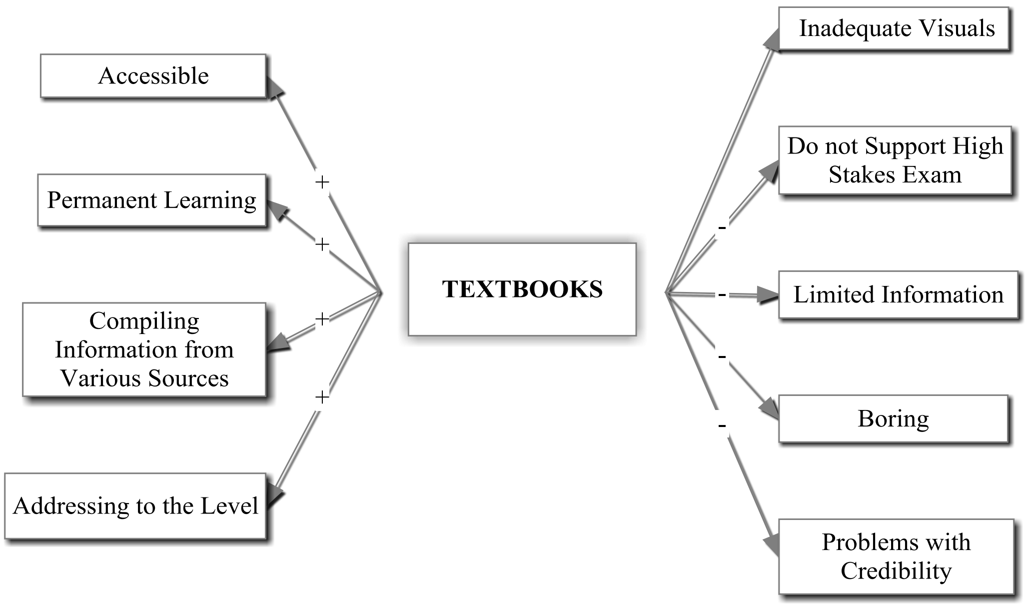

Figure 4.20. Effective and ineffective features and uses of textbooks as SIS.

The analysis of the interviews indicated that there were also ineffective features of the way textbooks presented science content to the students. Among these features, presenting science in a general way was criticized by the students as they would like to learn more about the details. To demonstrate, S42 (5th Grader, Private School B) said:

> I do not think that it [textbook] is useful for me…I mean in some chapters the information is good. The information in the textbooks do not address to children`s level. I think, the textbooks are directly produced considering…S/he [student] will learn…I mean they [students] will learn science…thinking this…it is covering all science with an idea in mind that they [students] will have an idea on many subjects.

Some of the students explained that they read textbooks because they had to. For example, S17 (4th Grader, Private School A) stated that she and her classmates used textbooks only in the class. She added that when she was searching for information she found it easy to use internet or magazines. Similarly, S28 (5th Grader, Public School A) expressed:

> In my opinion it [textbook] is only understandable. Rather than this, it is all boring. I read it because I have to.

As a matter of fact, the students were in a tendency to conceptualize textbooks as an “in-class science information source”. S17`s (5th Grader, Private School A) ideas on textbooks was remarkable:

> There is information in the textbook but sometimes it is too boring. That is why it is more fun to research it [science] from the internet or science magazines. We use textbooks in only class environments. I do not use it otherwise. I find it easy to use magazines and the internet.

The analysis of the interviews revealed that the students mainly did not like the layout of the textbooks as they had limited visuals making it easier to understand the content. Therefore, the students thought that textbooks were boring, did not address their levels, and were not beneficial anymore. Commenting on the textbooks as SIS, P9 suggested that it would have been better if textbooks had been prepared with the collaboration of TÜBİTAK as he liked the content presentation of TÜBİTAK magazines and books. Likewise, S37 commented that:

> For instance while we are reading science magazines there are some other supportive games that take our interest. But textbooks…Reading. I mean just reading…

<u>Content Presentation of Science Books as SIS</u>

Science books were reported to be used as one of the major SIS due to the way they presented the content. As seen in Figure 4.21, science books were reported to have some effective and ineffective features regarding the content presentation. In the first place, the students indicated that science books were fun with various colorful pictures and styles.

Combining the information from various other sources, science books presented the topics in detail and were typically understandable for the students. By way of illustration, S46 (5^{th} Grader, Private School B) noted that:

> They [science books] cover the same topic through the entire book in a more detailed, interesting, and brief way [than the textbooks]…but in the textbook, there is less information because there are too many units. There are many science books on different topics and they may explain the things as a whole book.

T1 and T16 commented that science books were effective in students` science learning as science books addressed different learning styles of the children and presented various information in different ways. The students believed that science books increased their curiosity and love towards science. Especially comics in the science books and visual elements were the most favorite parts for the students. Some representative quotes:

> I have a series of books covering all the school subjects. I learn [science] better with the comics inside these books. (S28, 5^{th} Grader, Public School A)

> The textbook does not take my interest anymore (…) Science books especially in science and technology are more fun with the comics. It [science book] both takes my interest and easy to understand. (S1, 4^{th} Grader, Public School A)

What is more, P3, P8, P9, and P10 claimed that among the science books, TÜBİTAK publications were their children`s favorite ones. Those books presented trustable and permanent information with experiments which motivated the students and attracted their attention. Visuality of those materials was implied by the interviewees several times. To illustrate, P9 said that:

> He [child] wants us to observe it as well, to witness his experiment…Let`s say he experimented something related to balloons in the book. He feels like he discovered it. Very effective when he experimented and observed.

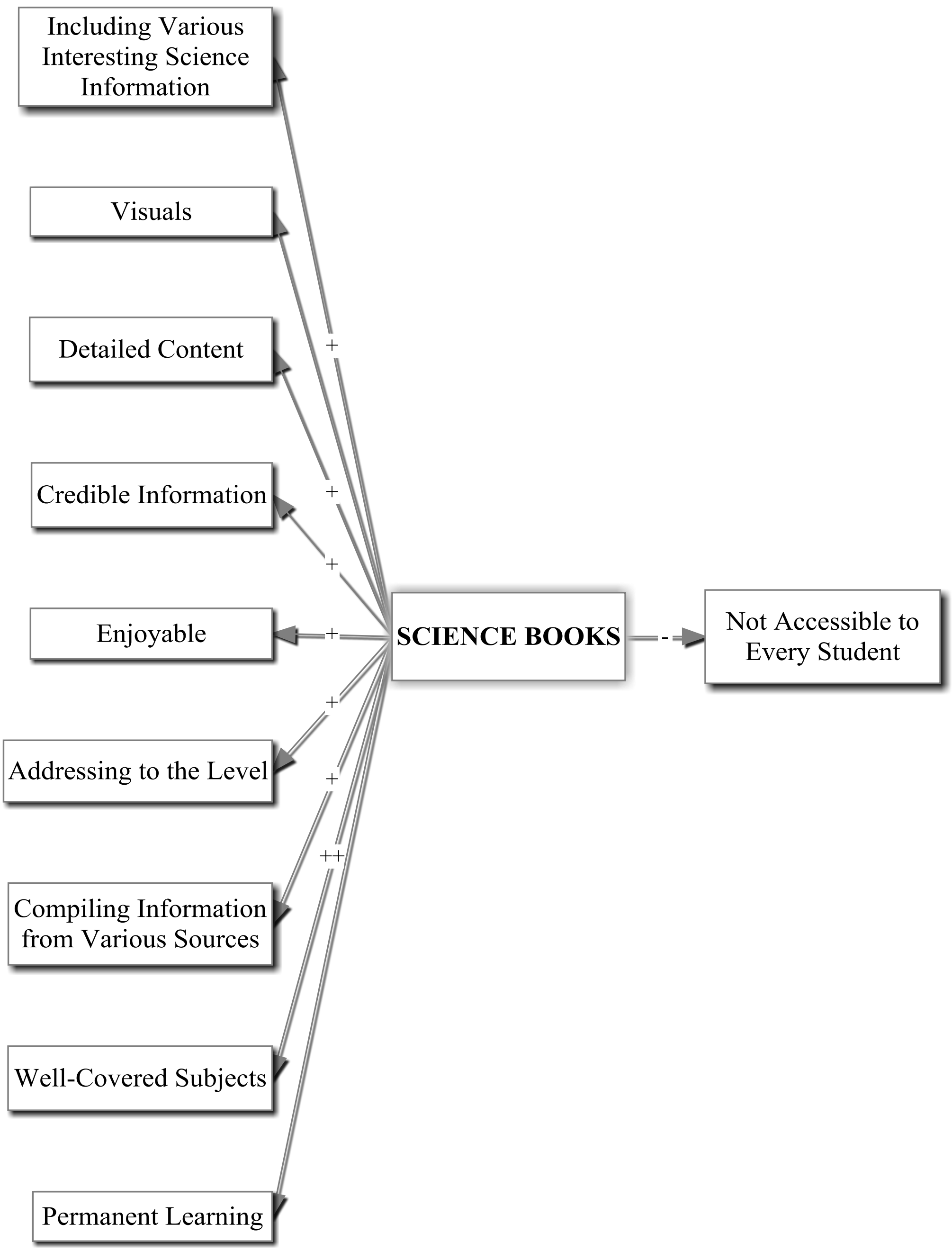

Figure 4.21. Effective and ineffective features and uses of science books as SIS.

As a limitation of the science books, both teachers and parents underlined that students at that age group (10-12) did not like reading-required materials. Specifically, P7 regretted that his child did not have a reading habit or like reading. That is why, any material including long texts were not effective for his child. Likewise, one of the teachers explained:

> The reason obstructs a science magazine, an article, a book, a newspaper with regards to communication is "texts". (T17)

In brief, except the low level reading habit among the students, science books had many effective content presentation features like comprehensible, enjoyable, and, brief science content presentation with visual support.

Content Presentation of Educational Programs as SIS

Educational programs were among the major SIS in terms of the presentation of science related content. As demonstrated in Figure 4.22, these programs hold mostly effective features regarding how they present science. The students commented that they preferred animations in educational programs to any kind of book, because visual elements built long-running knowledge in students` minds. Besides, S43 and P3 explained that these programs were useful as they were in harmony with the school curriculum. S43 said:

> I think they [educational programs] are really good because it [science information learned from here] is very long lasting in my mind. They are also connected to our school units. (S43, 5th Grader, Private School B)

Complementing what the students said about the role of educational programs, T9 also said that these programs reinforced the school science subjects. Apart from this, especially, students stated that they found the games they played and the experiments they watched enjoyable in science learning. Some representative quotes are as follows:

> It is fun. I like to play games immediately after I learnt something. I think it is really interesting. (S9, 4th Grader, Public School B)

> My father bought me Morpa Kampüs and I subscribed to it. I study to the various courses there. It is very fun. I enter to the science section and I cover five subjects consecutively. There are also games and I play them

all. Actually, Morpa Kampüs is really fun. (S14, 4th Grader, Private School A)

It [educational software] is absolutely fun and interesting. It is both audio and visual and it has information from many sources. I mean, lots of information... It is enjoyable. (S5, 4th Grader, Public School A)

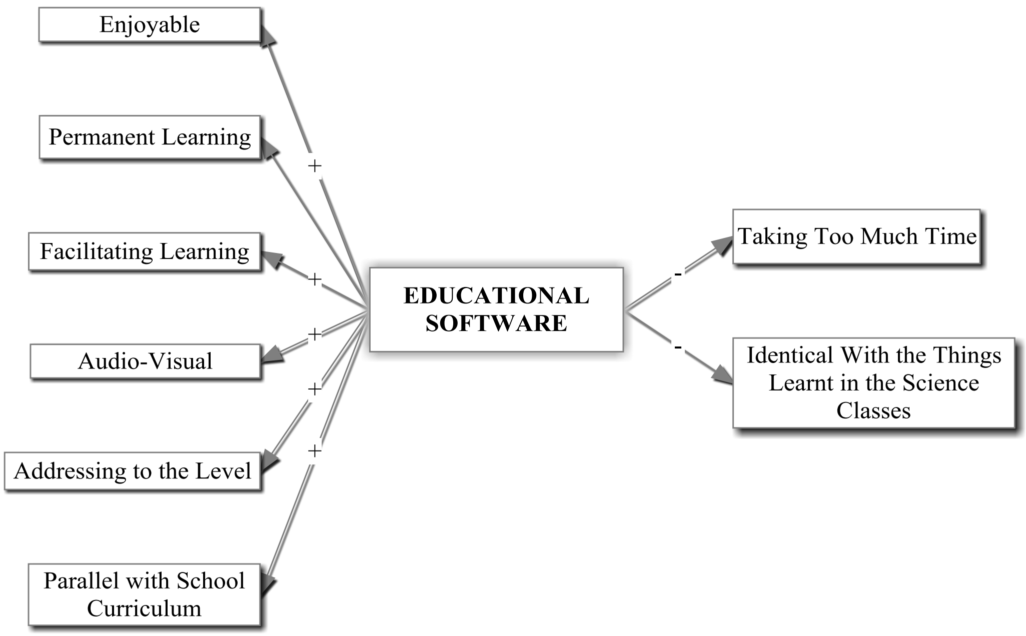

Figure 4.22. Effective and ineffective features and uses of educational software as SIS.

In the same vein with students, P7 and P8 commented that educational software products were easy to access and effective with its visual, audio, and animated features. As also mentioned by S5 (4th Grader, Public School A):

It is absolutely fun and interesting. It is both audio and visual and it has information from many sources. I mean, lots of information...It is enjoyable.

Educational software products were also reported to provide authentic experiences for students with visual and audio content. For T8, educational videos were advantageous because whenever he would like to talk about something he might stop the program and run it again.

Although the educational programs were found to have advantages like being parallel with school curriculum and presenting the content with audio-visual support as demonstrated by Figure 4.22, T6 criticized educational software for distracting students` attention. In coping with this, she explained that she sometimes turned off the voice and made students read the text on the projected screen. In addition to what T6 stated, T1`s complaints were in twofold: Firstly, it was difficult for them to use these software products in science classes since they wasted a great deal of time with physical arrangement. Secondly, they had limited time to fulfill the course requirements due to the density of the science curriculum. In this respect, T9 added that educational software products were supplementary science information sources as they were superficial and presented the content without details.

Content Presentation of Science Centers/Museums as SIS

Science in science museums/centers provided quality, interesting, credible, fun, and re-collective learning environments through three dimensional and touchable exhibits. The students interviewed had quite positive attitudes to science centers/museums. To illustrate, one student said:

> Good quality. We learn many things. There we may find information about how science progressed over time. It is fun, enjoyable. (S5, 4th Grader, Public School A)

Students also commented that hands on experiments in centers/museums increased their curiosity and love towards science. For example, one student reflected on his experience:

> Science centers/museums are both enjoyable and they increase my love towards science. It is [science learning in science centers/museums] enjoyable because museums are surrounded by many pictures and visuals. It is very good to examine them. (S36, 5th Grader, Public School B)

What is more, students admitted that they preferred science centers and museums to science books, other sources that include visual elements, and even to their teachers as museums enhanced visual and hands on environments. Hands-on minds-on experiements were found to be increasing students` curiosity and love towards science. As underlined by teachers and parents as well, school trips to science centers and museums provided the students with the opportunity to experiment the exhibits and have first hand information with authentic materials. By way of illustration, two students commented on this as follows:

> It is very good from the angle of visuality. We may touch if we would like to. We cannot do it [touching] for TV or books (…) I think science centers and museums are the best [among the other SIS]. (S27, 5th Grader, Public School A)
>
> In science centers/museums, we see authentic materials and thus, they are reliable. They are more interesting because we see it directly with our eyes, they are not like pictures on the internet. (S21, 4th Grader, Private School B)

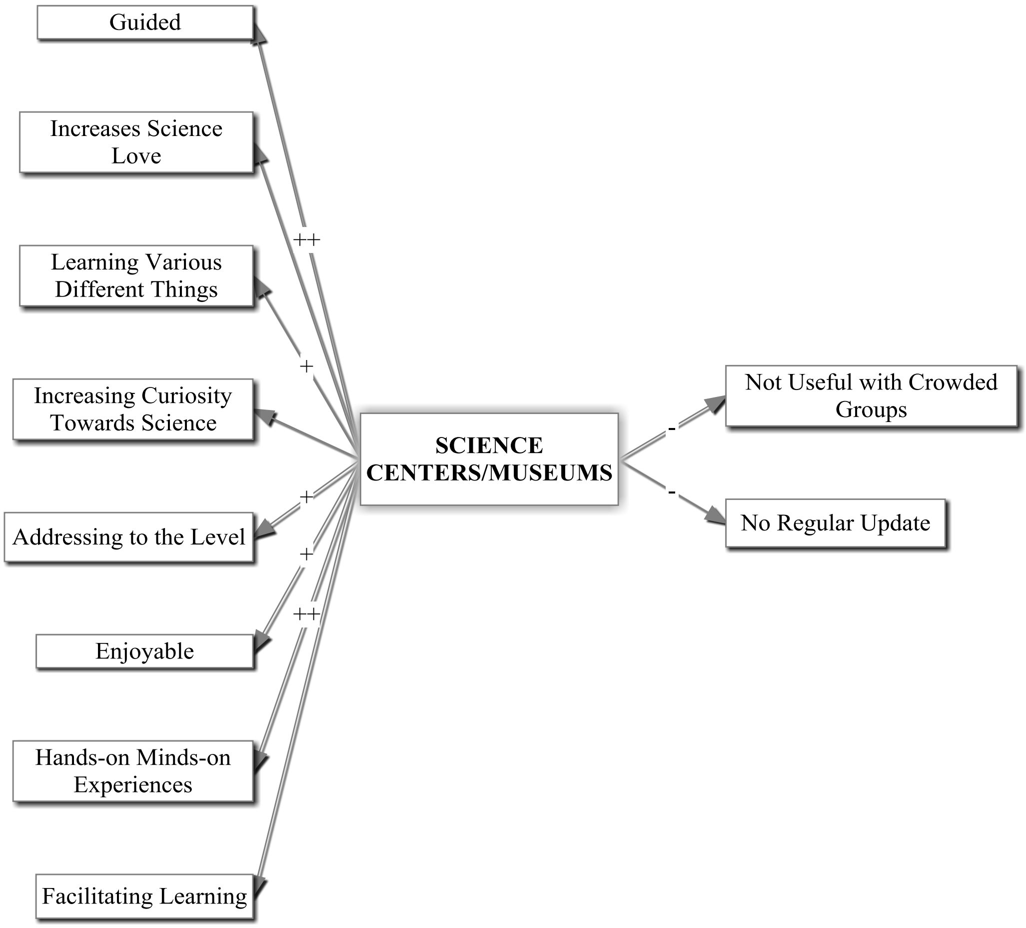

Figure 4.23. Effective and ineffective features and uses of science centers/museums as SIS.

Some student also explained that they took photos and notes during their visits. To illustrate, two students asserted:

> (…) I always go to museums with my small notebook and I take notes in relation to the exhibits. (S28, 5th Grader, Public School A)
>
> When I notice interesting materials in the science centers/museums, I take their photos and then draw them at home to hang somewhere in my room. (S20, 4th Grader, Private School B)

According to T8, P8, and P9, in science centers and museums, children were involved with hands-on activities which provided permanent knowledge for them. Additionally, T6 emphasized that science centers and museums presented trustable information to students, as also highlighted many times by the other interviewees. With a different perspective from the other interviewees, T6 asserted that science centers and museums were very useful in revealing students` science interests. This was because science centers and museums had exhibits in relation to the various branches of science. In addition to this, T16 (Private School B) suggested that science center/museum trips would be more effective if students had rubrics or directions in relation to their museum visits. Furthermore, she explained that they always pre-visited the site, before a museum trip and prepared a worksheet for children to be used during museum trip, as well.

Interestingly, science learning in museums was found to provide mainly "unintended learning" in public schools because students were not aware of the things they would come across in a museum environment. S34 (5th Grader, Public School B) illustrated that she was wondering about how people found writing, and she added that she did not access this information through the internet, her parents, or teacher but from science centers. She added that she did not even predict that she could find such kind of information in the museum environment but she confirmed that she learnt it. In private schools, teachers explained that they visited the site before the actual trip with students, took notes about "What they would like to learn in this unit" and prepared plans and rubrics to facilitate the learning. Otherwise, T16 (Private School B) implied that visiting a science center or a museum became an ordinary visit without any learning outcomes with it.

Criticizing science centers and museums for just having fun elements without teaching anxiety, T9 claimed that science centers/museums did not present permanent science learning environments for students at that age group. According to him, museum visits should also be supported by theoretical background of the experiments and should be spread out over time. In other words, visits in limited time intervals were not effective in students` science learning anymore although these visits could increase students` curiosity towards science.

Content Presentation of Science Camps as SIS

The analysis of the interviews showed that science camps played a significant role in students` science learning. As seen in Figure 4.24, students said that science camps were fun, enjoyable, and interesting. Topics in the science camps were organized through their levels and understandable. Increasing the students` curiosity and love towards science, science camps were found to be beneficial in terms of spending time efficiently. Sharing the experiences of one of her friends who had participated in science camps, S1 (4th Grader, Public School A) expressed that:

> …Because science learning in science camps is visual, touchable, you experiment with the things. For example, you stay in an environment without gravity, you learn how it [the experiment] is.

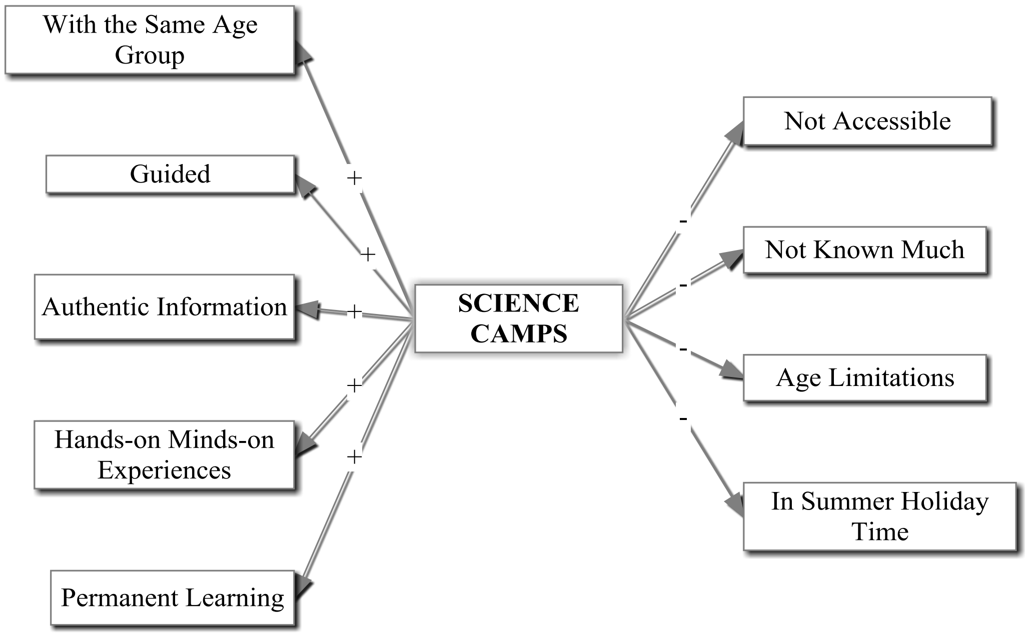

Figure 4.24. Effective and ineffective features and uses of science camps as SIS.

In line with this, S1, T1, T2, T3, and T5 stated that science camps were very effective while presenting hands-on, visual experiences with guided programs. Moreover, with science camps, students learned science on their own without the actual guidance of their teachers and parents, but collaboration with their peers.

Reflections on SIS

Overall, as seen in Figure 4.25, characteristics of an ideal SIS were examined through accessibility, content, and content presentation. Key drivers corroborating students` use of the SIS revolved around the sources providing comprehensible (e.g., textbooks, science books, science magazines, teachers, families, science centers/museums), brief (e.g., science magazines, science books, textbooks), interesting (e.g., TV, internet, science magazines, science books, science centers/museums), credible (e.g., teachers, science centers/museums, newspapers), to the level science information (e.g., teachers, families, textbooks, science books, and science magazines), in a fun-enjoyable way (e.g., science magazines, science books, sometimes teachers, families, and internet). Furthermore, the accessible sources (e.g., TV, internet, families, teachers, textbooks) underpinned by visual elements without long texts (e.g., TV, educational software products, and science magazines) were found to be more relevant to the students` needs in learning science. The students were more interested in the sources increasing their curiosity towards science (e.g., TV, internet, science magazines, science books) and instilling permanent science information (e.g., science magazines, textbooks, science exhibitions).

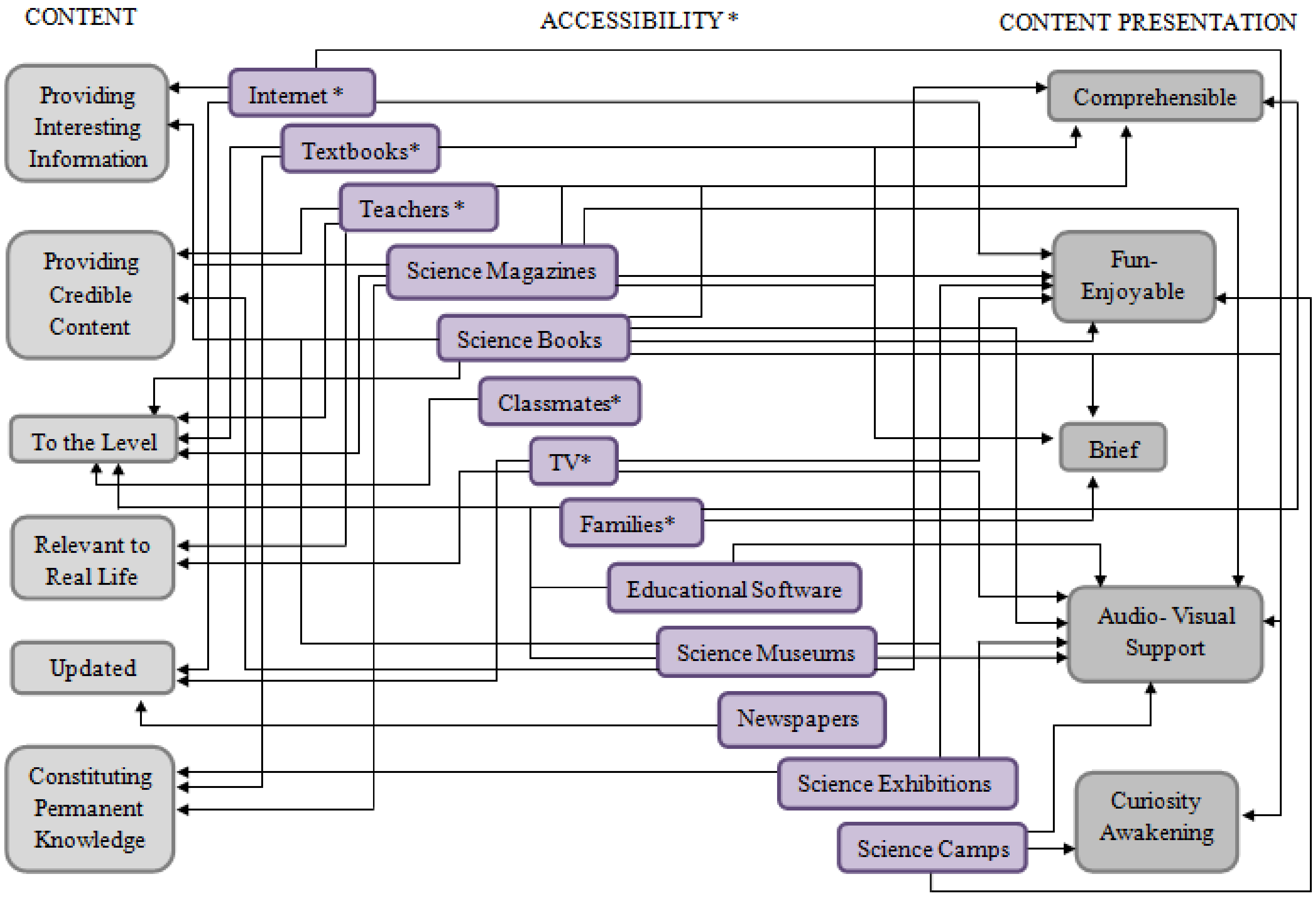

Figure 4.25. Effective features of SIS.

Note. (*) Accessible sources. The direction of the arrows shows the direction of the relationships among the elements. Sources in the middle were placed randomly.

4.4. Combining School and Beyond School Sources

The analysis of the data from various sources indicated that the students were able to use sources from different contexts in learning science, which appears to take place in two ways: combining and transferring. For teachers and parents, each context had its own dynamics and unique supplementary features supporting the combination of those two in increasing students` learning science. According to T8, school based environments provided prior knowledge to students while school beyond environments built on the existing knowledge base while reinforcing prior knowledge. Moreover, T12 stated that: "Science cannot be attributed to just one context like school based or school beyond [contexts]." The students were also of the opinion that science existed everywhere. To illustrate, for S9 (4th Grader, Public School B): "Science is everywhere" and S7 (4th Grader, Public School B): "Science is learnt from everywhere."

Science books, internet, and sometimes science magazines were both school based and school beyond use among the students. S44 (5th Grader, Private School B) explained how he transferred his science experiences through different contexts as follows:

> First, I learn science from the experiments we did in the school. Then, I try the same or similar experiments at home by myself and I make this information permanent in my mind.

S3 (4th Grader, Public School A) further explained that all science information sources were meaningful in bringing science to him because he would like to learn science through all dimensions: "Experimenting, seeing, touching, hearing..."

When the parents and teachers were asked the following question: "Where do you think students learn more science, in school based (using textbooks, teacher, classroom materials, etc.) or school beyond contexts (using science centers/museums, science camps, scientists, parents, etc.)?", most of the interviewees replied that they did not prefer to separate these contexts since they believed that different contexts feed into each other. To put in other words, those two different contexts were supplementary to each other and they could produce effective science learning process together if a cooperation between them was initiated. With a different perspective, one of the parents (P7) explained that information that was learnt from beyond school sources like TV or internet did not always provided deep or permanent knowledge compared to the formal education. Moreover, T6 responded that choosing the “right” ways mainly depended on children`s interest. For instance, if a child was not interested in school and science subjects, then school based sources became mostly used sources in these students` science learning. Reversely, if a child was interested in science subjects, then school based information and sources were getting superficial since the child had already researched the things from out-of-school based sources. This highlights the significance of the connection between daily life and outside learning.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

> Science, I maintain, is an absolutely essential tool for any society (...)
> And if the scientists will not bring this about, who will?
>
> Carl Sagan

This chapter presents the discussion of the results in line with the themes and codes produced through qualitative analysis of the interviews, observations, and documents/artifacts. It continues with the implications for practice and further studies, respectively.

5.1. Conclusions

Scientific and technological discoveries push the boundaries of our understanding of the world almost on a daily basis. "Science and technology play an increasingly important role in all aspects of our lives" (Feinstein, 2009, p.765). Therefore, educators and communicators alike have struggled with the transition from dealing with what science *can* do to what science *should* do as a topic of inquiry. Unfortunately, neither discipline has made sufficient progress in terms of figuring out how to develop curricula that prepare students for the challenges of a rapidly changing technological world. As two different disciplines, science education and science communication have their own unique features and dynamics. These two disciplines have many points of connection. In the end, they serve for each other (Tichenor et al., 1970; Neuman, 1981) and in the big picture they serve for science.

Within the framework of the connection between science communication and science education, the aim of this study was to discover the meaningful science information sources (SIS) and their uses in learning science. Students access science information through various sources. The uses and processes in using those sources require an in-depth analysis of the reasons or drives that determine students` use of those specific sources. This process further categorizes these sources as effective or ineffective based on what their features are and how these features are utilized for science learning. Parallel with this, reflections based on the results are presented under three main headings in line with the research questions: SIS, uses of SIS, and effective and ineffective features and uses of SIS.

5.1.1. Science Information Sources Used

Students in this study draw on the science information sources both in school and beyond school contexts for various science learning purposes. These science information sources were media sources: TV, internet, newspapers, and science magazines besides other sources like textbooks, science books, educational software products, teachers, classmates, families, science centers/museums, science exhibitions, and science camps. Most of the parents and teachers in the study agreed that rather than drawing lines between school based and school beyond environments, it would be better to make use of a variety of sources both in school and beyond school in promoting science learning. Rather than valuing one context over another, participants were in a tendency to assess the contexts as a "whole" contributing to students` science learning in an equal way. A system of K-12 science education that integrates in-school and out-of-school sources may better serve the needs of diverse student groups. In addition to that, these different settings offer opportunities to link student engagement to academic content without some of the constraints of time and the school curriculum (Bull et al., 2008). This would be considered as part of the frame of bridging science communication to science education. Presenting science through different sources is important in addressing the needs of different students and creating different science learning experiences. Mentioning about the different contexts of learning Caravita (1987) asserts that:

> The integration between in-school and out-of-school education can promote conceptual change. The two contexts have their own characteristics (…) both should contribute to enlarging the range of

phenomenological evidences and exemplars that people can take into account (…) (p.59).

However, parent participants of the study admitted that teachers were not equipped enough to combine these two learning contexts and they were unaware of how to incorporate school beyond science learning environments with those environments appeared in schools as also pointed out by Ramey-Gassert (1997). Complementing with what parents said, there was agreement among teachers that different sources could be used in science courses and teachers were aware that they could not do this. This finding is consistent with those of Fidan (2008) and Karamustafaoğlu (2006). However, the quality of learning context is very important in students` engagement in science (NFER, 2011). Some public school students and teachers in this study found school science learning dull and boring which was consistent with what Stocklmayer (2001) stated. It was full of demonstrations rather than experiments, which constituted the base for the negative attitudes of the participants towards the notion and concept of science.

The results of the study indicated that students` SIS use differentiated through school types. To begin with, public and private schools differentiated in sources used in classrooms. Observations as well as individual and focus group interviews indicated that students` science information sources in school contexts were their teachers, textbooks, documentaries, cartoons, science books, science magazines, their classmates, and educational software products. Typically, in public schools, textbooks and teachers were the main SIS in science courses along with educational software products and science books whereas sources in private schools included sources from documentaries, science magazines, and classmates with a slight emphasis on textbooks and teachers.

Science is not only limited to textbook-driven teaching practices (Weiss et al., 2003). However, observation and interview analysis indicated that science courses in public schools were basically teacher and textbook-driven as also some of the public school students complained. This finding corroborated the ideas of Clark (2000) who stated that: "The teacher and textbook are typically the only sources and, students are taught to accept information from these sources without question" (p.860). Although textbooks were the only accessible and affordable resource for education, they were not enough as discussed by NCERT (2006). However, the results of the study also revealed that textbooks were not among the main SIS in private schools. Many teachers, parents, and students explained that they found the textbooks dull, with limited information and long texts. What is more, some of the parents and students claimed that textbooks sometimes contained unreliable information. As an accessible resource in science education, if textbooks had been revised and organized on the content and content presentation, it could have probably motivated students to utilize the textbooks significantly more and yielded much more effectiveness in science learning. For this, textbooks could have been organized with a collaborative group including faculty members and publishers like TÜBİTAK.

Next, among out-of-school contexts, internet and science books were found as the commonly used SIS by the 4th and 5th graders. Apart from these sources, private school students stated using TV, science magazines, and centers/museums for science learning purposes in school beyond contexts. A possible explanation for these differences among the students from different types of schools might be related to the socio-economic status differences between these two groups. In other words, uses of science information sources especially in out-of-school contexts might be related to the income level of the students (Harvard Family Research Project, 2007). Royal Society Report (2008) also refers to the issue: “There is strong evidence of a link between SES and attainment in science among 5-11 year olds” (p.4). Moreover, “SES is also among the factors that influence the knowledge and experience children bring to the classroom” (Duschl et al., 2007, p.3).

One unanticipated finding of the study was directive and directed sources. In reviewing the literature, no study was found on the association between directed and directive sources. However, the students in this study explained that some sources led them to the other sources to learn further about the topic or if they had further questions. These “directive” sources were their teachers, parents, TV, science magazines, and science centers/museums. On the other hand, the directed sources were teachers, families, internet, and science books. The results indicated that this kind of direction could be resulted from the lack of sufficient information provided by directive sources. However, teachers and families were both a “directive” and “directed” source at the same time. This could be explained by the differences among teachers and families on their qualifications necessary for a meaningful science information source which will be discussed in detail next. In line with this, this finding may suggest two things: (1) sources should not be considered to function separately, in isolation from each other, and (2) even things we think of as relatively static, such as textbooks, can direct students to the other sources; it is not humans alone that do this.

According to Fenichel and Schweingruber (2010), active engagement in science information sources have a positive impact on young students. For instance, participant students whose parents asked questions during TV programs stated to have more permanent science information than passively receiving the information. When this social, conversational approach is embedded TV, it might become a more interactive source.

5.1.2. Various Ways of Using Science Information Sources

Based on what is said in uses and gratification theory, people make use of the media to satisfy their specific needs (Katz, Gurevitch, & Haas, 1973). One of the basic principles of the U&G theory is the active audience (Blumler & Katz, 1974). Accordingly, the audience makes decisions about their own consumptions through their needs. With a broader perspective to the U&G theory, the students in this study used various sources apart from the media to meet their social and psychological needs. Of the five categories of human needs cited by Katz, Gurevitch, and Haas (1973), the results of this study focused on four: Cognitive needs, affective needs, personal integrative needs, and social integrative needs.

To begin with, students employed textbooks, science books, internet, families, and classmates for homework/project requirements. This use could be resulted from students` cognitive needs which was explained by Katz, Gurevitch, and Haas (1973) as “needs related to strengthening information, knowledge, and understanding” (p.52). Although the teachers and parents mostly criticized the use of internet as a SIS, the results indicated that among the aforementioned SIS, the internet stepped to the fore. This finding was in agreement with what Butt et al. (2010) and Bubela et al. (2009) suggested. Most of the teachers believed that rather than sticking to one source, the science information was more permanent in students` minds when they conducted research with many sources.

The results further indicated that sources, textbooks, science books, and families were in students` use for preparation for exams and tests. Again, here, students` cognitive needs seemed to be precursor of this consumption. The parents, especially who had related educational background, were the sources while students were studying for their exams and tests. Textbooks were being used while students had school related exams. Science books were mainly in use for preparation of nationwide exams.

Another use of the SIS was related to students` individual science related research. Here, it is important to note that students did not conduct individual science research unless it was required by school. However, they explained that they preferred using the internet, science books, science magazines, textbooks, and families since these sources were accessible and they were presenting rich information. Students also shared interesting things they found in class. There were cognitive, personal, and social integrative needs behind this kind of use as also explained by Katz, Gurevitch, and Haas (1973). Accordingly, by conducting individual research, students did not only gain information, knowledge, and understanding (cognitive needs), but also they strengthened their emotional experience (affective needs) and contact their friends, and teachers (social integrative needs) while sharing these with other people.

TV, internet, newspaper, and magazines were the sources that students would like to share about their recent findings with. The main purpose of choosing those sources in sharing the outcomes was the source accessibility which corroborates the ideas of Senemoğlu (2001), who suggested that an educational material should be both accessible and usable. This finding which revealed the desire to share the findings with people might be further explained by students` personal (gaining prestige, high standing) and social integrative needs (contacting with people) in line with what Katz et al. (1973) offer.

One other unanticipated finding was the generational differences between parents and students about the use of SIS. This, combined with the parents` frustration about doing their children's homework for them, suggests that there is more general tension surrounding which sources should be used for what. One suggestion for improving the clarity and effectiveness of assignments might be for teachers to make it clear which sources are appropriate, when, and why.

5.1.3. What Makes SIS Effective or Ineffective for Students` Science Learning?

The results revealed that key drives corroborating students` use of the SIS revolved around accessibility, content and its presentation and quality of these sources. Accordingly, accessible sources (TV, family, internet, textbooks) with interesting (TV, internet, science magazines, science centers/museums), trustworthy (teachers, science books, science centers/museums, newspapers), to the level (teachers, parents, textbooks, science books, science magazines, science centers/museums), and updated (TV, internet, newspaper) content were found to be preferable for students. Furthermore, sources instilling permanent, memorable science information (TV, science magazines, teachers, parents) were also defined under the category of effective features.

In relation to the content presentation following aspects gained importance in students` use of SIS: comprehensibility (textbooks, science books, teachers, families, science centers/museums), fun-enjoyable (science magazines, science books, internet, sometimes teachers and families), clarity (TV, science magazines, science books), visuality (TV, science books, science magazines, science books, educational software products), which awakened students` curiosity (TV, internet, science magazines, science books).

The media sources were mostly regarded as "updated" sources which addressed "a wide array of people" by the participants of the study. Among the media sources, the internet held the top position through many uses since it was a convenient and accessible source. This result corroborated with the findings of a great deal of the previous work in this field (Butler, 1995; Clark, 2000; Falk & Dierking, 2010; Horrigan, 2006; NFER, 2011). Clark (2000) further supported this finding on internet as follows: "This new resource provides rich opportunities to support the development of scientific argumentation skills, going well beyond those available in typical instruction" (p.859). However, in public schools, internet was chiefly in use for presentation purposes (e.g., accessing sites like slaytyerim.com, slaytizle.com) in the science courses. This finding is consistent with Hakverdi-Can and Dana`s (2012) study that found teachers unaware of using internet as an interactive tool to take virtual trips to museums and zoos, and science centers, access online databases, or to participate internet-oriented workshop rather than just presentation purposes.

Credibility of the source was another issue that was highlighted by the students. In other words, the students would like to access accurate science information. This finding is in agreement with what was offered in CIBA Foundation Conference (1987). Among the sources aforementioned, internet, textbooks, and parents were somehow problematic in reliability through the science information students accessed. The results indicated that teachers, science books, science centers/museums, and newspapers were thought to provide credible information for students. Hass (1981, as cited in Clark, 2000) stated that: "Source credibility is associated with high levels of education, intelligence, professional attainment, and familiarity with the issue" (p. 860). In contrast to Horrigan`s (2006) study in which the participants felt the internet as a credible source to check on science information, participants of this study mostly criticized the internet on reliability and authenticity of the science information that students accessed through. In order to cope with this issue, students tried to check the accuracy of their online findings with other websites or sources like their families, teachers, and science books. This result was in agreement with the Horrigan`s (2006) study resulting that "Fully 80% of those who have gotten science news and information online have engaged in at least one of these 'fast-checking' activities" (p.2).

The students involved in the study implied that science learning was more meaningful and permanent in their minds when science was illustrated with many examples and real life experiences. Here, the findings regarding connecting school-based and school-beyond environments were consistent with Cajas`s (1999) study which implied that connecting school science with students` everyday lives was an educational goal which looked simple, plausible, and desirable. “Learning is ubiquitous in ongoing activity, though often unrecognized as such” (Lave, 1993, p.5). Situated learning theory advocated the context and application of knowledge rather than memorizing facts (Heeter, 2005). On the other hand, for the students, the TV had permanent or memorizable science elements which were in contrast to the study of Gregory and Miller (2000).

The results also revealed that visuality of the SIS was another aspect that made the source effective. Reading comprehensiveness is decreasing among students and thus, sources with visual aspects are gaining importance (Birkök, 2008). At this point, sources like TV, educational software, and science centers/museums were among the effective visual sources that were stated by participants.

Another important finding was that fun and enjoyable aspects of the content provided by the sources were influential in students` choices. Accordingly, TV, internet, science magazines, science books, and science centers/museums were the sources with the entertainment function. This finding corroborates the ideas of Gilbert (2008), who states that "The argument goes that the general public is uninterested in science and technology as not being ‘fun’, they will lead to public to a more general willingness to engage with science and technology" (p.123).

Students emphasized the fun and enjoyable feature of out-of-school science learning, which is a feature suggested by NFER (2011) as well. Besides, students in this study also sought for these aspects for in-school science learnings, as well. Alexander (2000) points out “the learning lies between play and academics" (p.1), which underlines the fun elements of teaching and learning science. This is also consistent with what NFER (2011) suggests:

> Promoting science as interesting and fun by capitalising on, and demonstrating, the potential for science to be interesting, fun and engaging so as to avoid potential negative perceptions of it as boring or difficult. There is a need to look for connections and build upon positive experiences of science education developed earlier on in young people’s school careers. (…) Hence, it is important to maintain and extend that early interest to encourage young people’s engagement with the subject during and beyond the compulsory period. (p.8)

However, the teachers often complained that they could not compete with the entertainment provided by the media or museums. Actually, classroom cannot provide the diverse opportunities that children have beyond school environment (Dillon, 2012). In the same vein with this, the purposes of teaching are different from those of the media because "the teacher tries to build a deeper understanding rather than just presenting the surface of the phenomena" (CIBA Foundation Symposium, 1987, p.79). This also indicates that we need formal education. "Formal education is the place in which we are guided in the development of basic skills and introduced to new realms of knowledge" (Dierking, 2005, p.148). That is why some students found in-school environments dull and boring. Apart from this, the students in the study had fun and enjoyment when their teachers gave illustrations with practical applications, when they did experiments, watched documentaries, or played games in relation to science. This result might be explained as these students would like to see the connection of science with life. The reason why the media sources and science centers/museums took students` attention (as being fun and enjoyable) might be interpreted by this, as well. The media sources and museums mainly connected science content with real life.

Family, including parents, siblings, close family members like aunts, nephews, and cousins were the other science information sources for the students. According to a World Bank Report (2011), these were "significant individuals" in students` engagement with science education (p.29). Similarly, Miller (1987) elaborates on this and states that "…the most effective source of attitudes toward science and mathematics is the family" (p.177). The current literature on science education has also a place to parental issues as an important contributor to children`s science learning (Dierking & Falk, 2003; Rounds, 2004). Complementing the literature, this study suggested that educated parents were helpful in their children`s science learning. Although some of the teachers complained that parents sometimes caused misconceptions among students, they further emphasized that parents were effective in students` science learning. Therefore teachers said that they established certain science requirements for children to be accomplished with the help and support of their parents.

5.2. Implications for Practice

The results of this study offer some implications for practice. Based on the data collected through interviews, observations, and documentation; school-based (eg., teachers, school admistrations) and school-beyond contexts (eg., media, science centers/museums, families) and government policies on education and universities (eg., faculty members) were found to be all decisive in students` science learning as demonstrated in Figure 5.1. In line with this, the implications for practice will be presented within the researcher`s suggestions and experience in the field.

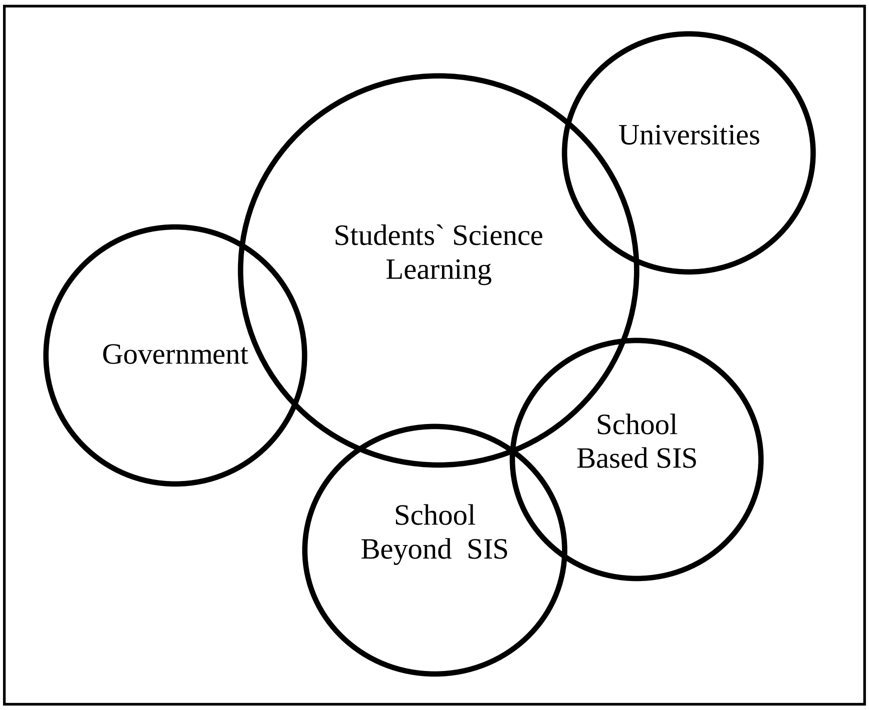

Figure 5.1. Science learning infrastructure.

<u>TV as a SIS</u>: It was found that TV programs mostly addressed to the adults and science programs for children programs were mostly published in the mornings and afternoons while students were in school. Thus, students could not use TV in accessing science information, which decreased the effectiveness of the TV as a SIS. In addition, commercials and advertisements were found to be distracting elements. At this point, suggestions might be ordered for TV producers, teachers, and parents. If it is possible, TV producers could publish

children science programs in the evenings and at the weekends without too much commercials and other distracting elements. In addition, what is suggested for teachers is to encourage students to conduct science research by using TV, to watch science programs on TV, and to inform students about what channels and programs to watch in advance. In parallel with this, parents should observe their children carefully about TV watching and guide them about conscious TV choices.

Newspapers as a SIS: It was found that newspapers were criticized for addressing to adults, having insufficient science content, and presenting information with long texts and limited visuals. Furthermore, newspapers were not an accessible SIS. These caused low motivation among students to use newspapers as a SIS. These findings suggest that newspapers should communicate science to children through various channels like including a "science page" in the content composition, publishing a visual-colorful "child science page" besides the common pages, or publishing "child newspapers" at least once a week as an addition to the newspapers. Here, the idea of including a "science page" or "science story" in a newspaper does not necessarily mean to change the readers` expectations on a particular composition like sports at the back, lots of news about politics as discussed by Gregory and Miller (2000), but still it would be meaningful to make use of this accessible and widespread source as a SIS. Moreover, newspapers might be posted to school libraries daily so as to give a chance to schools and students from low SES to access science through newspapers. At this point, teachers and parents should encourage students to recognize newspapers as a SIS and to use it in accessing science information.

Science Magazines as a SIS: The results indicated that science magazines were effective in students` science learning in many ways: comprehensibility, fun-enjoyable, brief, visual support, interesting, awakening curiosity, instilling permanent science information, increasing curiosity and science love, etc. However, science magazines were not accessible to each and every student. The data suggest that it would be a wise enterprise to distribute science magazines to the school libraries monthly so as to enhance the accessibility. Again, here, teachers and parents should support students to take science magazines as a SIS and to use it in accessing science information.

Textbooks as a SIS: The findings of the study revealed that the students did not find the textbooks sufficient in terms of contributions of the textbooks to in-school science learning process and their further science related research. This is obviously not to ascribe a primary role to the textbooks; however, curriculum and textbooks might be revised regularly in order to prepare students for the challenges of a rapidly changing technological world. Gilbert (2008) says that science education fails to keep itself up to date with progressions in science, or it does so slowly. In dealing with this, changing textbooks and publishing them every single year could not be reasonable considering financial limitations, but more updated sources may be integrated into school curriculum to better teaching and learning processes. In order to remedy this, the new project introduced in public education called “FATİH” (Movement to Increase Opportunities and Technology) might be a solution. The project is being carried out by the Ministry of Education with an aim to turn classes into smart classes equipped with the latest information technologies by delivering tablet PCs and smart boards to schools across Türkiye (MoNE, 2012). Therefore, it seems like textbooks will be replaced with tablet PCs. Here, the use of these tablet PCs in science learning as well as its effectiveness in students` science learning might be investigated.

Internet as a SIS: There was a clear indication in this research that students` internet use was one step ahead in comparison to the other SIS. Students in this study expressed a preference for using internet with purposes like homework/project and individual science research as discussed in Chapter IV. However, teachers and parents criticized internet content for problems in credibility besides distructful and inappropriate elements. These findings suggest that students should be suggested appropriate sites and guided about internet use regarding especially which sites to visit, what information to trust, and how much information to get by teachers and families.

Parents as a SIS: Participants in this study indicated that families who acted as an effective science information source were those who helped their children to access appropriate information, encouraged their children to draw on many sources, and guided them in using those sources. Thus, parents should be aware of the importance of their roles as a SIS for their children and behave accordingly to constitute positive influence on their children`s attitudes towards science.

Students as Science Communicators: The results revealed that especially public school students had difficulty in conducting research and sharing it with their teachers and peers. In schools, children might be given the chance of conducting their own research via different sources and they could be encouraged to share the outcomes with their peers and other interested individuals. As Chung and Behan (2010) assert this kind of science activities that included peers motivated students and sharpened their abilities to apply and communicate their knowledge of science.

Students and Teachers as Learners: The students in this study were willing to learn about the recent science developments. As an alternative event, in addition to the highly mentioned SIS, “Cafe Scientifique” might be organized. This is an event enabling people to come together and meet with scientists in an informal, relaxed cafe environment. It encourages people to learn about the recent scientific and technological developments while they are having their coffees. “Junior Cafes”, which started in Lyon, in France in 1999 and has continued in the USA, Japan, and Germany are held for students between 15-18 years old with very similar principles of its “senior” predecessor (Grand, 2009) This activity could be organized in Türkiye as well also including the 4^{th} graders onwards and educators as well.

Teachers as a SIS: The findings of this study has also raised the concern about teachers who acted as an effective and ineffective science information source. Accordingly, teachers who made science courses comprehensible, enjoyable, and interesting motivated students to develop an interest to science. However, teachers who talked in length, did not provide enough guidance or help, did not give right to speak to students during classes, and carried out textbook-based instruction were found to have ineffective features as a SIS. This clearly indicates the importance of well-equipped and enthusiastic teachers with a high quality of education and professional development.

Professional Development: The results of the study indicated that some of the teachers in public schools did not find themselves adequate in teaching science with various experiments and activities. In coping with this, teachers, as science information sources, might participate in in-service trainings regularly which are offered by scientists and faculty members in order to update their knowledge and develop an awareness regarding the recent scientific and technological developments. These trainings might also be rooted on how students learn science and how to teach science (Duschl et al., 2007) besides use of the sources in their instruction (Hakverdi-Can & Dana, 2012).

Revision of Teacher Preparation Programs: This study further suggests that pre-service teachers in Science Education Departments should be taught the social contexts of science, the principles of science communication, how to communicate with the media and the contexts in which a scientific message is delivered. Integrating communication elements into the pre-service science education teacher programs seem to make a significant difference in enriching the science education with science communication elements as also asserted by Ramey-Gassert (1997): "Understanding the pivotal role of the teacher is an important piece of the change implementation puzzle, starting with teacher preparation programs and professional development of in-service teachers" (p.444). The findings also revealed that teacher education programs should also include elements of the use of SIS in science courses as well as highlighting the connection between school based and school beyond SIS.

Science Centers/Museums as a SIS: The results revealed that field trips to centers and museums were ineffective unless students were guided by center staff and given a worksheet to be used during the visit. Moreover, visits with crowded groups were found to be ineffective as well. Without applying those suggestions, visits were stated to be nothing more than fun and enjoyment. Thus, in order to use science centers/museums as an effective SIS, teachers should pre-visit the site before a museum trip and prepare a rubric/worksheet for children to be used during museum trip.

Science Exhibitions as a SIS: Participants in this study explained that they appreciated the importance of science exhibitions, but the exhibitions were just for temporary time periods and they were uninformed about the current science exhibitions. This finding suggests that, teachers, school administrations, parents, and students should follow the recent events, and if possible, organizations could invite schools to the science exhibitions.

Science Camps as a SIS: Although they were highlighted many times by the students, the participation and use of science camps were low among 4th and 5th graders. Participants reasoned this for science camps` inaccessibility, age limitations with being in summer time. Moreover, most of the parents and teachers admitted that they have never heard about this kind of organization before. Therefore, science camps might be introduced to schools and parents to be used as a SIS by the host institutions (TÜBİTAK, universities). Furthermore, schools might arrange their schedules to give some time to the participation of science camps at the end of the term before holiday, or they might even organize a similar event in the schools with the collaboration of faculty members as well.

Combining Different Sources: The participants in this study agreed that combining different contexts and sources would be more meaningful in students` learning science. In this context, newspapers, TV, internet, and science magazines may be integrated into the curriculum to keep students up to date about the recent scientific developments. No matter how formal or informal, TV and internet significantly affect child and adult lives. Conceptualizing media as a science information tool is something new, but a considerable new issue. Almost in every single house, TV is a kind of *inventory stock*. The internet here almost competes with TV. These media sources are generally attributed to science communication but if they are irrevocable in our lives we may find the ways to benefit them as a supporting tool for science education as well. In this context, capitalizing on the accessibility of television and the internet as a way of reaching young people and stimulating their interest in science could be a useful way forward (NFER, 2011). In line with this, the current research suggests if these various sources work together, they are more likely to become successful in bringing science to people.

Revision of the Science Curriculum: The teachers in this study complained about the obstacles like overloaded curriculum and lack of time to make use of different sources in the classroom or include “fun” and “interesting” activities in science classes. Therefore, the findings of this study suggest a re-organization in units to be able to provide more time to the enriched activities in science classes to foster the teaching and learning process that result in effective learning. It can be also suggested that science curriculum and teacher books should be revised including suggestions to teachers for use of SIS.

5.3. Implications for Further Research

In this section, the researcher presents recommendations for the researchers who would be interested in conducting future studies on science education and science communication through the findings of the present study:

Studies on Science Communication: It is clear that Science Communication is a very fertile but untouched field of study for Türkiye. This study underlined a call for further research which science education and science communication scholars align their efforts with using the connection between these two disciplines. In this context, qualitative and quantitative studies focusing on adults` and/or young audiences` understanding of science and uses of various sources would contribute to the literature.

Observing Students in Out-of-School Contexts: In this study, students were observed in in-school science learning environments. To understand what is learned and to see how it is learned within the activity context, students might also be observed in out-of-school contexts.

Conducting Think-Aloud Protocols: The main data collection tool used in this study was interviews. Specifically, focus group interviews were used to have an in-depth understanding of students` science learning experiences. As an alternative data collection tool, students might be interviewed on the uses of the SIS as well as the effective and ineffective features of the SIS in use.

Mixed Design Studies: Based on the complementary nature of science education and science communication, this study investigated the SIS including the media sources in students` use along with the effective and ineffective uses and features of these sources in science learning. Interview protocols were developed based on the preliminary interviews with the students, teachers, and parents as well as the current literature. Therefore, in the development of the instrument, the pilot data from a limited group was reflected to the instruments. Besides, this study could be regarded as a basis for the large scale developments. For future studies, interview guide might be further developed through the pilot interviews and based on the results of this study, a scale might be developed in order to assess the impact of the media science and/or the other well-known SIS on students` science learning. Despite the difficulties in gathering and interpreting data especially from the media science (Gregory & Miller, 2000), longitudinal studies might be conducted on a qualitative and quantitative basis to understand if the science information has any impact.

Longitudinal Studies: In order to understand better how children accumulate science learning experiences and how this process contributes to adult interest of science, longitudinal studies along with qualitative and quantitative methods might be conducted. This kind of study would be both meaningful for science education and science communication literature in terms of closing the gap regarding what happens when children accumulate science experiences.

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APPENDICES

APPENDIX A

INTERVIEW PROTOCOL FOR STUDENTS (ENGLISH VERSION)

4^{th} and 5^{th} GRADE STUDENT FOCUS GROUP INTERVIEW PROTOCOL
Dear students- This study is related to my Ph.D. dissertation. I am studying about your usage of the sources such as TV, newspaper, internet, books, etc. and your interactions and conceptions on these sources. Your personal information and answers to questions will be kept confidential and will be used for the sake of this study. In order to reach reliable results it is very important to answer my questions sincerely. In order to catch everything you said I want to record the interview. If you feel unsafe or change something we may delete the record and start again. The interview will last about 120 minutes. Thank you for your participation! **Res. Assist. Sevinç Gelmez-Burakgazi** **Middle East Technical University** **sgelmez@metu.edu.tr**
DEMOGRAPHICS
1. School: 2. Class: 3. Gender: 4. Age: 5. Your grade in science course in last term: 6. Mother education level / job: 7. Father education level / job: 8. How often do you use these sources in your daily life: (never, once a year, once a day etc…) TV? Internet at home? Internet at school? Reading newspapers? Visiting museums? Visiting exhibitions?

INTERVIEW QUESTIONS
1. How do you define “science”? Sub.1.1. What do you think about the features of `scientific knowledge`? Sub.1.2. Can you give examples to scientific knowledge? What kind of scientific knowledge you learnt up to now? Sub.1.3. What do you think about the ways to reach scientific knowledge? Sub.1.4. How do you reach to scientific knowledge? (personally) **2.** Is there any object, living thing, or an activity, etc. to define science? Could you draw this? Sub.1.1. Why did you choose this? What do you want to explain here? **3.** Are you interested in science? Sub.3.1.What is your most favorite science subject? Sub.3.2. Are you conducting research on this subject? Which sources are you using? Sub.3.3. How do you benefit from these sources? HINT: taking notes, reading, listening… **4.** Think about a typical science course…How does the course flow? Think about from the beginning of the course…Teacher comes into the class…is saluting you… Sub.4.1. What kind of sources are you using? (textbook, other scientific books, internet, watching scientific videos, etc.) Sub.4.2. What kind of activities are you doing? (teachers` instruction, writing, watching videos, reading book, doing experiments, etc.) Sub.4.3. Which of these sources used in the class are making you understand the science better? Through what aspects? Why? Sub.4.4. Which of these sources used in the class are increasing your interest towards science? Through what aspects? Why? **5.** Do you use science information sources in science learning? (How often you do?) . I watch scientific programs in TV . I make scientific explorations in internet . I read scientific news in newspaper . I read scientific magazines . I read science in my textbook . I read the scientific books other than my textbook . I use scientific educational software . I ask my teacher about science subjects . I ask my family about science subjects . I talk to my peers on science subjects

. I visit science centers/ museums
. I participate in science exhibitions
. I participate in science camps

Sub.5.1. What do you think about these frequencies? Is it enough or would you want to increase/decrease the time you devoted? Why?
Sub.5.2. How do you benefit from these sources?
Sub.5.3. What do you think about the features of the knowledge you got through these sources?
HINT: Easy to understand, attractive, enjoyable, intriguing, etc.

6. If all science would be communicated to you with one of the sources we mentioned, which one/ones would you pick up? Through what aspects? Why? Could you explain it?

. TV
. Magazines
. Newspaper
. Internet
. Family
. Teachers
. Peers
. Textbooks
. Science books
. Educational software
. Science museums/centers
. Scientific exhibitions
. Science camps

7. Which science subjects you remember from the last year?
Sub.7.1. Where did you learn them from? What do you think about the reasons make you remember?

8. Think about the last homework or project you did in science course. Did you conduct any research for this task? Thinking from the time you learnt the homework/project…Which sources did you use? How did you gather data from these sources? Why did you prefer these sources? Could you explain it?
Sub.8.1. How do you benefit from/use these sources?

9. In the future would you prefer to have a job related to science and technology? Which subject would you want to study? Why?
Sub.9.1.How did you decide this?
Sub.9.2.Which experiences directed you to think like that?

10. Suppose that you become a scientist in the future. You have the chance of working on the subject you find interesting and important.

What would you study?

Sub.10.1. When did you feel interest on this subject?

Sub.10.2. Which experiences / sources motivated you to think like that? Why?

11. Suppose that you discovered remarkable things in your field of study. Do you want to share your findings with people to inform them?

Sub.11.1. How?

PROMPT: Which sources would you prefer?

Sub.11.2. In your opinion what is the most effective way to share the knowledge with people?

12. We are talking about sources of science and science communication for a while. Have you heard about “science communication” before? What do you think about “science communication” or what comes to your mind first?

Sub.12.1. Could you draw this?

Sub.12.2. Why did you choose this?

Sub.12.3. What do you want to explain here?

This is the end of interview! Is there anything you want to add? Thanks for participating! ☺

INTERVIEW PROTOCOL FOR STUDENTS (TURKISH VERSION)

4. – 5. SINIF ODAK GRUP ÖĞRENCİ GÖRÜŞME FORMU

Sevgili öğrenciler- Bu çalışmayı doktora tezim ile ilgili yapıyorum. TV, gazete, internet, kitap, vs. gibi kaynakları kullanımınız ve bilimsel bilgi edinmeniz ile ilgili düşüncelerinizi öğrenmek istiyorum.

Kişisel bilgileriniz ve cevaplarınız sadece bu araştırma için kullanılacaktır. Düşünceleriniz benim için çok önemli. Sizin için uygunsa, görüşmemizi kayıt altına almak isterim. İstediğiniz kısımda görüşmeyi durdurabilir ve kaydı da silebiliriz. Görüşmemiz yaklaşık 2 saat sürecek. Katılımınız için teşekkür ederim.

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GENEL BİLGİLER

1. Okul:
2. Sınıf:
3. Cinsiyet:
4. Yaş:
5. Geçen dönem Fen ve Teknoloji dersinden aldığın not:
6. Anne öğrenim durumu / mesleği:
7. Baba öğrenim durumu / mesleği:
8. Bahsedeceğim kaynaklardan günlük hayatında hangi sıklıkta yararlanıyorsun? (hiçbir zaman, yılda bir, ayda bir, haftada bir, vb.)
   TV?
   Evde internet?
   Okulda internet?
   Gazete?
   Müzeler?
   Sergiler?

GÖRÜŞME SORULARI

1. "Bilim" nedir sence?
   1.1. Bilimsel bilginin özellikleri neler olabilir?
   1.2. Bilimsel bilgilere örnek verebilir misin? Ya da ne tür bilimsel bilgiler öğrendin şu ana kadar?
   1.3. Bilimsel bilgiye nasıl ulaşabiliriz sence? (Nerede, nasıl öğrenilir?)
   1.4. Senin bilimsel bilgiye ulaştığın oldu mu? Nasıl?

2. "Bilim"i tarif eden bir nesne, canlı ya da aktivite vs. aklına geliyor mu? Bunu çizer misin?

2.1. Neden bunu seçtin? Burada ne anlatmak istiyorsun? Açıklar mısın?

3. Bilime/bilimsel bilgiye karşı ilgi duyuyor musun?

3.1. En çok ilgini çeken fen konusu / bilimsel konu nedir?

3.2. Bununla ilgili araştırma yapıyor musun? Hangi kaynakları kullanıyorsun?

3.3. Bu kaynaklardan nasıl yararlanıyorsun?

İPUCU: okuma, dinleme, yazma, not alma, vb...

4. Fen ve teknoloji dersini düşün… Genel olarak bir ders nasıl geçiyor? Başından sonuna neler yapıyorsunuz? Öğretmen içeri giriyor…Sizi selamlıyor… Bu andan itibaren başlayarak düşünecek olursan…

4.1. Sınıfta ne tür kaynaklar kullanıyorsunuz? (ders kitabı, diger bilimsel kitaplar, internet, eğitimsel video (Morpa Kampüs, Vitamin vs.), çalışma kitabı, dergi, gazete…)

4.2. Neler yapıyorsunuz? (yazı yazma, video izleme, kitap okuma, deney yapma, soru cevap, vs.)

5. Bahsedeceğim kaynakları fen öğrenme amacı ile kullanır mısın?

- Televizyonda bilimsel bilgi içeren programları izlerim.
- İnternette bilimsel araştırmalar yaparım.
- Bilimsel bir dergi (Bilim Çocuk, National Kids, vs.) okurum.
- Gazetede bilimsel haberleri okurum.
- Öğretmenime bilimsel bir konu hakkında danışırım.
- Aileme bilimsel bir konu hakkında danışırım.
- Fen ve Teknoloji ders kitabımı okurum.
- Ders kitabım dışında bilimsel kitaplar okurum.
- Eğitimsel yazılım programları kullanırım (Morpa Kampüs, Vitamin, Zambak, vb.)
- Sınıfta akranlarıma bilimsel bir konu hakkında danışırım.
- Bilim merkezlerini/müzelerini ziyaret ederim.
- Bilimsel sergileri ziyaret ederim.
- Bilim kamplarına katılırım.

5.1. Bu kaynakları kullanım sıklığın hakkında ne düşünüyorsun? (daha fazla ya da daha az zaman ayırmak)

5.2. Bu kaynaklar yoluyla edindiğin bilimsel bilginin özellikleri nelerdir? Bu kaynaklardan nasıl yararlanıyorsun?

İPUCU: Anlaşılması kolay, ilgi çekici, eğlenceli, bilime karşı sevgimi arttırır, merak duygusu uyandırır

6. Fen ve teknoloji dersi kapsamındaki bilgiler / bilimsel bilgi tamamen bahsedeceğim kaynaklardan biri/birileri yoluyla iletilecek olsaydı, sen hangisini/hangilerini tercih ederdin? Hangi yönleriyle? Neden? Açıklar mısın?

- TV
- Bilimsel dergiler
- Gazete
- İnternet
- Aile
- Öğretmen
- Sınıf arkadaşları
- Ders kitapları
- Diğer bilimsel kitaplar
- Eğitimsel yazılım programları
- Bilim müzeleri/merkezleri
- Bilimsel sergiler
- Bilim kampları

6.1. Senin bu bahsettiğin kaynaklardan en çok hangileri fen konularını/bilimsel konuları anlamanı kolaylaştırıyor? Hangi yönleriyle? Neden?

6.2. Bahsettiğin kaynaklardan en çok hangileri fen konularına/bilimsel konulara karşı ilgini arttırıyor? Hangi yönleriyle? Neden?

7. Ne tür fen ve teknoloji bilgileri ya da derste karşılaştığın bilimsel konuları (geçen yıldan) hatırlıyorsun?

7.1. Bu bilgileri nereden öğrendin? Bunu hatırlamanı sağlayan sebepler ne olabilir?

8. Fen ve teknoloji dersinde en son yaptığın ödevi düşün. Bu ödevi yapabilmek için araştırma yaptın mı? Ödev konusunu öğrendiğin andan itibaren düşünecek olursak… Neler kullandın? Bu kaynaklardan nasıl bilgi topladın? Neden bu kaynakları tercih ediyorsun? Açıklar mısın?

8.1. Bu kaynaklardan nasıl yararlandın?

9. Gelecekte bilim ve teknoloji ile ilgili bir konuyla ilgili çalışmak / böyle bir meslek edinmek ister misin?

9.1. Hangi konuda çalışmak istersin? Neden?

9.2. Bu düşünce nasıl/ne zaman oluştu?

9.3. Ne tür deneyimler seni böyle düşünmeye teşvik etti?

10. Varsayalım ki ileride bir bilim insanı oldun. İlginç bulduğun ve önemli olduğunu düşündüğün herhangi bir konuyu araştırmakta özgürsün. Bir araştırmacı olarak neyi araştırmak istediğinden bahseder misin?

10.1. Bu tür bir konuya ne zaman ilgi duydun?

10.2. Ne tür bilgiler ya da kaynaklar seni bu yönde düşünmeye motive etti? Neden?

11. Araştırmaların sonucunda alanında oldukça önemli şeyler bulduğunu düşün şimdi de. Bu sonuçları insanlara duyurmak onları haberdar etmek ister misin?

11.1. Nasıl? Hangi yollarla/kaynaklarla?

11.2. Ne tür bilgiler ya da kaynaklar seni bu yönde düşünmeye motive etti? Neden?

12. Bir süredir bilimin iletilmesinden / iletişiminden bahsediyoruz; bu ifadeyi daha evvel hiç duydun mu, nasıl? Ne düşünüyorsun "bilim iletişimi" dediğimde, ya da ilk aklınıza ne geliyor?

12.1. Bunu çizer misin?

12.2. Neden bunu seçtin?

12.3. Burada ne anlatmak istiyorsun? Açıklar mısın?

Görüşmemiz burada sona ermiştir. Eklemek istediğin herhangi birşey var mı? Teşekkür ederim! ☺

APPENDIX B

INTERVIEW PROTOCOL FOR TEACHERS (ENGLISH VERSION)

TEACHER INTERVIEW PROTOCOL

Dear participant- This study is related to my Ph.D. dissertation. I am studying how 4th and 5th grade students use of in-school and out-of-school sources such as TV, newspaper, internet, textbooks, science centers/museums etc. to learn about science. I'm also interested in your ideas about your students` usage of these sources.

Your personal information and answers to questions will be kept confidential and will be used for research purposes only. In order to reach reliable results it is very important to answer my questions sincerely. In order to catch everything you said I want to record the interview. We can stop the record at any time and start over if you wish. The interview will last about 40-50 minutes. Thank you for your participation.

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DEMOGRAPHICS

1. Gender /Age:
2. Graduate School / Field:
3. Experience in Job (How long have you been working as a teacher?):
4. School:
5. Grade level of the students/ number of students:
6. SES of students –in general-
7. Internet connection in school:
8. Science lab that is open to students` access in school:

INTERVIEW QUESTIONS

1. I'm going to list a number of sources that students might use to learn about science. Could you please say how often, in your experience, your students benefit from using each source?
   . Science programs in TV
   . Science explorations in internet
   . Reading science news in newspaper
   . Reading science magazines
   . Reading about science in their textbook
   . Reading the science books other than their textbook
   . Asking family about scientific subjects

. Asking you about science subjects
. Talking science with peers
. Watching educational programs
. Visiting science centers/ museums
. Visiting science exhibitions
. Participating in science camps

1.1. What do you think about these frequencies? Is it enough or do you think they should increase/decrease the time they devoted to learn science? Are there particular sources that students should use more or less? Why?
1.2. What do you think about the features of science that your students gain through each of these sources?
HINT: accessible, easy to understand, enjoyable, etc.

2. Of the sources I listed which one/ones would be better to communicate science to your students? What features of the source/s you picked make it/them meaningful for you? Could you please explain that?
. TV
. Magazines
. Newspaper
. Internet
. Family
. Teachers
. Classmates
. Textbooks
. Other scientific books
. Scientific educational software products
. Science museums/centers
. Scientific exhibitions
. Science camps

3. Where do you think students learn more science, in-school (using textbooks, teacher, classroom materials, etc.) or out-of-class (using science centers/museums, science camps, scientists, parents, etc.). Please explain that a little bit more?

4. What science and technology subjects are your students most interested in?
4.1. How your students become interested in these subjects? Please explain that.

5. Which resources do your students use to help them in their home project or research in science course?

6. What resources are helpful to you in planning science curriculum and instruction?
PROMPT. How do you decide the way you handle the subject, the

activities you will do, or the time you will devoted to each of them? What kind of methods and strategies you benefit from in science classes?

6.1. How does the course flow?

7. What do you think about 4^{th}/ 5^{th} grade science curriculum?

8. During the interview I mentioned about in-school and out-of-school sources that I think important in students` learning science/ science communication. Were there any sources missing from this list that you feel contribute your students` understanding of science?

9. Have you heard the phrase *science communication* before? How? In your view, what is science communication?

This is the end of my questions. Is there anything you want to add?
Thank you for participation.

INTERVIEW PROTOCOL FOR TEACHERS (TURKISH VERSION)

ÖĞRETMEN GÖRÜŞME FORMU

Sevgili katılımcı- Doktora tezim kapsamında yürüttüğüm bu çalışmada 4. ve/veya 5. sınıf öğrencilerinizin bilim iletişimi kaynakları ile etkileşimleri konusunda görüşlerinize ihtiyaç duymaktayım.

Kişisel bilgileriniz ve cevaplarınız sadece bu araştırma için kullanılacaktır. Soruların tamamını içtenlikle yanıtlamanız daha doğru sonuçlara ulaşmam için oldukça önemlidir. Sizin için de uygunsa görüşmemizi kayıt altına almak isterim. Herhangi bir durumda kaydı durdurabilir ve tekrar başlayabiliriz. Görüşmemiz yaklaşık 40-50 dakika sürecek. Zaman ayırdığınız için teşekkür ederim.

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DEMOGRAFİK BİLGİLER

1. Cinsiyet / Yaş:
2. Mezun Olduğunuz Okul / Alan:
3. Meslekteki görev süreniz:
4. Görev yaptığınız okul:
5. Öğrencilerinizin sınıf düzeyleri / sınıf mevcudu:
6. Öğrencilerinizin sosyo-ekonomik düzeyi:
7. Öğrencilerinizin okulda internet erişimi:
8. Öğrencilerinizin kullanımına açık fen laboratuarı mevcut mu?

GÖRÜŞME SORULARI

1. Öğrencilerinizin fen öğreniminde kullanabileceği bir takım kaynakları sıralayacağım. Gözlemlerinize göre, öğrencilerinizin herbir kaynaktan hangi sıklıkta yararlandığını söyleyebilir misiniz?

- Televizyonda bilimsel bilgi içeren programları izlemek.
- Evde internette bilimsel araştırmalar yapmak.
- Okulda internette bilimsel araştırmalar yapmak.
- Gazetede bilimsel haberleri okumak.
- Bilimsel bir dergi (Bilim Çocuk, National Kids, vs.) okumak.
- Öğretmenine bilimsel bir konu hakkında danışmak.
- Ailesine bilimsel bir konu hakkında danışmak.
- Sınıfta akranlarına bilimsel bir konu hakkında danışmak.
- Fen ve Teknoloji ders kitabını okumak.
- Ders kitabı dışında bilimsel kitaplar okumak.

- Eğitimsel yazılım programlarını kullanmak (Morpa Kampüs, Vitamin, Zambak, vb.)
- Bilim merkezlerini/müzelerini ziyaret etmek.
- Bilimsel sergileri ziyaret etmek.
- Bilim kamplarına katılmak.

1.1. Siz bu sıklık hakkında ne düşünüyorsunuz? Öğrencilerinizin fen öğrenmek için ayırdığı zamanı yeterli buluyor musunuz? "Şu kaynaktan daha çok yararlanabilir" ya da "Bu kadar kullanmasını tercih etmezdim" diye özel olarak belirtebileceğiniz kaynak/lar var mı? Niçin?
1.2. Öğrencilerinizin bahsedeceğim kaynaklar yoluyla edindiği bilimsel bilginin özellikleri nelerdir?
İPUCU: kolay ulaşılabilir, anlaşılması kolay, eğlenceli, vb.

2. Fen ve teknoloji dersi kapsamındaki bilgiler / bilimsel bilgi tamamen bahsedeceğim kaynaklardan biri ya da birileri yoluyla öğrencilerinize iletilecek olsaydı, siz hangisini/hangilerini tercih ederdiniz? Neden? Bu kaynakların hangi yönleri onları seçmenize neden oldu? Açıklar mısınız?

- TV
- Bilimsel dergiler
- Gazete
- Internet
- Aile
- Öğretmen
- Akranlar
- Ders kitapları
- Diğer bilimsel kitaplar
- Eğitimsel yazılım programları
- Bilim müzeleri/merkezleri
- Bilimsel sergiler
- Bilim kampları

3. Sizce sınıf içi ortamlar mı (ders kitapları ve öğretmenin ders işlemesi) yoksa sınıf dışı ortamlar mı (bilim merkezleri, bilim kampları, bilim insanları) bilimsel bilginin öğrencilere iletişiminde daha etkili? Açıklar mısınız?

4. Öğrencilerinizin en çok ilgisini çeken fen ve teknoloji konusu nedir?
4.1. Bu konuya ilgi duymasını etkileyen sebepler / bilgi kaynakları (öğretmen, dergi, kitap vb.) neler olabilir? Açıklar mısınız?

5. Öğrencileriniz genel olarak (bir araştırma ödevi ya da proje sözkonusu olduğunda) hangi kaynaklardan yararlanarak araştırma yapıyor?

6. Fen ve Teknoloji dersini nasıl planlıyorsunuz? Hangi kaynaklardan yararlanıyorsunuz?

İPUCU: İşleyeceğiniz konuya, konuyu ele alacağınız şekle, yapacağınız etkinliklere, bunlar için ayıracağınız süreye nasıl karar veriyorsunuz? Ne tür öğretim metodları ve teknikleri kullanıyorsunuz?

6.1. Bir ders süreci nasıl geçiyor?

7. Fen ve teknoloji programını 4./5. sınıflar için nasıl değerlendiriyorsunuz?

8. Görüşmemiz boyunca öğrencilerinizin bilimsel bilgiye ulaşmak için kullandığı sınıf içi-sınıf dışı kaynaklardan bahsettik. Öğrencilerinizin bilimsel bilgiye ulaşmasına katkıda bulunan eklemeyi unuttuğum, sizin ilave etmek isteyeceğiniz kaynak var mı?

9. *Bilim iletişimi* kavramını daha evvel duydunuz mu? Nasıl? Bilim iletişimi dediğimde neler düşünüyorsunuz? Bilim iletişimi nedir sizce?

Görüşmemiz sona ermiştir. Eklemek istediğiniz herhangi bir şey var mı? Teşekkür ederim.

APPENDIX C

INTERVIEW PROTOCOL FOR PARENTS (ENGLISH VERSION)

PARENT INTERVIEW PROTOCOL

Dear participant- This study is related to my Ph.D. dissertation. I am studying how 4th and 5th grade students use of in-class and out-of-class sources such as TV, newspaper, internet, textbooks, science centers/museums etc. to learn about science. I'm also interested in your ideas about your child`s usage of these sources.

Your personal information and answers to questions will be kept confidential and will be used for research purposes only. In order to reach reliable results it is very important to answer my questions sincerely. In order to catch everything you said I want to record the interview. We can stop the record at any time and start over if you wish. The interview will last about 30-40 minutes. Thank you for your participation.

Res. Assist. Sevinç Gelmez-Burakgazi
Middle East Technical University
sgelmez@metu.edu.tr

DEMOGRAPHICS

1. Gender /Age:
2. Education Level / Field:
3. Profession:
4. Monthly income:
5. Residence:
6. Internet connection at home:
7. Grade level of child and his/her school:
8. Your relationship with student:

INTERVIEW QUESTIONS

1. How often does your child use these sources in his/her daily life? (never, once a year, once a day etc…)

TV?
Internet at home?
Internet at school?
Reading newspapers?
Visiting museums?
Visiting exhibitions?

2. I'm going to list a number of sources that your child might use to learn about science. Could you please say how often, in your experience, your child benefits from using each source?

. Watching scientific programs in TV
. Scientific explorations in internet
. Reading scientific news in newspaper
. Reading scientific magazines
. Asking teacher about scientific subjects
. Asking family about scientific subjects
. Talking science with peers
. Reading about science in their textbook
. Reading the scientific books other than their text book
. Watching educational software programs
. Visiting science centers/ museums
. Participating in science exhibitions
. Participating in science camps

2.1. What do you think about these frequencies? Is it enough or do you think your child should increase/decrease the time s/he devoted to learn science? Are there particular sources that students should use more or less? Why?
2.2. What do you think about the features of science that your child gains through each of these sources?
PROMPT: accessible, easy to understand, enjoyable, etc.
2.3. Of the sources I listed is there any source you support your child to benefit? Which one/ones? Could you explain why.

3. Of the sources I listed which one/ones would be better to communicate science to your child? What features of the source/s you picked make it/them meaningful for you? Could you please explain that?

. TV
. Magazines
. Newspaper
. Internet
. Family
. Teachers
. Peers
. Textbooks
. Other scientific books
. Educational software
. Science museums/centers
. Scientific exhibitions
. Science camps

4. Where do you think your child learn more science, in-class (using textbooks, teacher, classroom materials, etc.) or out-of-class (using science centers/museums, science camps, scientists, parents, etc.). Please explain that a little bit more?

5. What science and technology subjects is your child most interested in?

5.1. How your child become interested in these subjects? Please explain that.

6. Is there any special activity you do in order to increase your child`s science interest? Please explain that.

7. During the interview I mentioned about in-class and out-of-class sources that I think important in students` learning science/ science communication. Were there any sources missing from this list that you feel contribute your child`s understanding of science?

8. Have you heard the phrase *science communication* before? How? In your view, what is science communication?

This is the end of my questions. Is there anything you want to add? Thank you for participation.

INTERVIEW PROTOCOL FOR PARENTS (TURKISH VERSION)

VELİ GÖRÜŞME FORMU

Sevgili katılımcı- Doktora tezim kapsamında yürüttüğüm bu çalışmada velisi olduğunuz 4. ve/veya 5. sınıf öğrencilerinizin bilim iletişimi kaynakları ile etkileşimleri konusunda görüşlerinize ihtiyaç duymaktayım.

Kişisel bilgileriniz ve cevaplarınız sadece bu araştırma için kullanılacaktır. Soruların tamamını içtenlikle yanıtlamanız daha doğru sonuçlara ulaşmam için oldukça önemlidir. Sizin için de uygunsa görüşmemizi kayıt altına almak isterim. Herhangi bir durumda kaydı durdurabilir ve tekrar başlayabiliriz. Zaman ayırdığınız için teşekkür ederim.

Arş. Gör. Sevinç Gelmez-Burakgazi
ODTÜ Eğitim Bilimleri Bölümü
sgelmez@metu.edu.tr

DEMOGRAFİK BİLGİLER

1. Cinsiyet / Yaş:
2. Eğitim Durumu:
3. Meslek:
4. Ailenizin aylık geliri:
5. Oturduğunuz semt:
6. Evde internet erişiminiz mevcut mu?
7. Çocuğunuzun sınıf düzeyi ve okulu :
8. Öğrenciye yakınlık düzeyiniz:
9. Bahsedeceğim kaynaklardan çocuğunuz günlük hayatında hangi sıklıkta yararlanıyor? (Hiçbir zaman, yılda bir, ayda bir, haftada bir, haftada birkaç kez, hergün)
   Televizyon
   Evde internet
   Okulda internet
   Gazete
   Müze
   Sergi

GÖRÜŞME SORULARI

1. Çocuğunuzun bilim hakkında öğrenmek için kullanabileceği bir takım kaynakları sıralayacağım. Gözlemlerinize göre, çocuğunuzun herbir kaynaktan hangi sıklıkta yararlandığını söyleyebilir misiniz?

- Televizyonda bilimsel bilgi içeren programları izlemek.
- Internette bilimsel araştırmalar yapmak.
- Gazetede bilimsel haberleri okumak.

- Bilimsel bir dergi (Bilim Çocuk, National Kids, vs.) okumak.
- Öğretmenine bilimsel bir konu hakkında danışmak.
- Ailesine bilimsel bir konu hakkında danışmak.
- Sınıfta akranlarıyla bilimsel bir konu hakkında konuşmak.
- Fen ve Teknoloji ders kitabını okumak.
- Ders kitabı dışında bilimsel kitaplar okumak.
- Egitim programlari izlemek (Morpa Kampüs, Vitamin, Zambak, vb.)
- Bilim merkezlerini/müzelerini ziyaret etmek.
- Bilimsel sergileri ziyaret etmek.
- Bilim kamplarına katılmak.

1.1. Siz bu sıklık hakkında ne düşünüyorsunuz? Çocuğunuzun fen öğrenmek için ayırdığı zamanı yeterli buluyor musunuz? "Şu kaynaktan daha çok yararlanabilir" ya da "Bu kadar kullanmasını tercih etmezdim" diye özel olarak belirtebileceğiniz kaynak/lar var mı? Niçin?
1.2. Çocuğunuzun bahsedeceğim kaynaklar yoluyla edindiği bilimsel bilginin özellikleri nelerdir?
İPUCU: kolay ulaşılabilir, anlamaşılması kolay, eğlenceli, vb.
1.3. Saydığım etkinlikler arasında çocuğunuzun yapmasını desteklediğiniz etkinlik var mı? Hangileri? Neden?

2. Fen ve teknoloji dersi kapsamındaki bilgiler / bilimsel bilgi tamamen bahsedeceğim kaynaklardan biri ya da birileri yoluyla çocuğunuza iletilecek olsaydı, siz hangisini/hangilerini tercih ederdiniz? Neden? Bu kaynakların hangi yönleri onları seçmenize neden oldu? Açıklar mısınız?

- TV
- Bilimsel dergiler
- Gazete
- Internet
- Aile
- Öğretmen
- Akranlar
- Ders kitapları
- Diğer bilimsel kitaplar
- Eğitimsel yazılım programları
- Bilim müzeleri/merkezleri
- Bilimsel sergiler
- Bilim kampları

3. Sizce sınıf içi ortamlar mı (ders kitapları ve öğretmenin ders işlemesi) yoksa sınıf dışı ortamlar mı (bilim merkezleri, bilim kampları, TV) bilimsel bilginin öğrencilere iletişiminde daha etkili? Açıklar mısınız?

4. Çocuğunuzun en çok ilgisini çeken fen ve teknoloji konusu nedir?
4.1. Bu konuya ilgi duymasını etkileyen sebepler / bilgi kaynakları (öğretmen, dergi, kitap vb.) neler olabilir? Açıklar mısınız?

5. Çocuğunuzun bilime karşı ilgisini arttırmak için özel olarak yaptığınız herhangi bir şey var mı? Açıklar mısınız?

6. Görüşmemiz boyunca çocuğunuzun bilimsel bilgiye ulaşmak icin kullandığı sınıf içi-sınıf dışı kaynaklardan bahsettik. Çocuğunuzun bilimsel bilgiye ulaşmasına katkıda bulunan eklemeyi unuttuğum, sizin ilave etmek isteyeceğiniz kaynak var mı?

7. *Bilim iletişimi* kavramını daha evvel duydunuz mu? Nasıl? Bilim iletişimi dediğimde neler düşünüyorsunuz? Bilim iletişimi nedir sizce?

Görüşmemiz sona ermiştir. Eklemek istediğiniz herhangi bir şey var mı? Teşekkür ederim.

APPENDIX D

CLASSROOM OBSERVATION GUIDE (ENGLISH VERSION)

OBSERVATION GUIDE
Date: School: Class Size/Level: Duration: Name of the Unit: Subject: Aims of the Course: Physical Environment:
Instruction
Instructional Techniques Instructional Activities Instructional Materials/Sources (1) How do students use it?
Roles
The Role of the Materials/Sources (1) Quality (visual, sound, content, content presentation) (2) How are students introduced to the resource (verbal, note-taking, watching, demonstration, etc.)? The Role of the Teacher The Role of the Students
In-Class Communication
Communication Between Students and Teacher Communication Between Students and Textbook Communication Between Students and Other Materials

CLASSROOM OBSERVATION GUIDE (TURKISH VERSION)

SINIF-İÇİ GÖZLEM FORMU
Tarih: Okul: Sınıf: Sınıf Düzeyi/Mevcudu: Gözlem Süresi: Ünite Adı: Konu: Dersin Amaçları: Fiziksel Ortam:
Öğretim
Öğretim Teknikleri Eğitsel Etkinlikler Eğitsel Materyaller (1) Öğrencilerin materyalleri kullanımı
Kullanımlar
Materyallerin Rolü (1) Özellikler (görsellik, ses, içerik, içerik sunumu) (2) Öğrencilerin materyallere yönlendirilmesi (sözlü, not alma, izleme, gösteri, vb.)? Öğretmenin Rolü Öğrencinin Rolü
Sınıf-Içi İletişim
Öğrenci ve Öğretmen Arasındaki İletişim Öğrenci ve Ders Kitabı Arasındaki İletişim Öğrenci ve Diğer Materyaller Arasındaki İletişim

APPENDIX E

THE CONSENT LETTER OF HUMAN SUBJECTS ETHICS COMMITTEE (ENGLISH VERSION)

1956

Orta Doğu Teknik Üniversitesi
Middle East Technical University
Fen Bilimleri Enstitüsü
Graduate School of
Natural and Applied Sciences
06531 Ankara, Türkiye
Phone: +90 (312) 2102292
Fax: +90 (312) 2107959
www.fbe.metu.edu.tr

Sayı: B.30.2.ODT.0.AH.00.00/126/61 – 491

6th April 2011

To : Prof. Dr. Ali Yıldırım
Department of Educational Sciences

From : Prof. Dr. Canan Özgen
Vice Chairperson of Human Research Ethic Committee

Canan Özgen

Subject : Ethical Approval

The study titled " Contribution of "Science Communication" on Students' Perception of Science: Primary Education Students, Parents, and Teachers" was approved by "Human Researches Ethical Committee".

Sincerely,

Ethic Committee Approval

Appropriate

06/04/2011

Canan Özgen

Prof.Dr. Canan ÖZGEN
Applied Ethics Research Center
(UEAM) Chairperson
ODTÜ 06531 ANKARA

Ar. Gör. Sevinç Burakçı
ile. 8/4/11
AY

THE CONSENT LETTER OF HUMAN SUBJECTS ETHICS COMMITTEE (TURKISH VERSION)

1956

Orta Doğu Teknik Üniversitesi
Middle East Technical University
Fen Bilimleri Enstitüsü
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Natural and Applied Sciences
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Phone: +90 (312) 2102292
Fax: +90 (312) 2107959
www.fbe.metu.edu.tr

Sayı: B.30.2.ODT.0.AH.00.00/126/62-492

6 Nisan 2011

Gönderilen: Prof. Dr. Ali Yıldırım
Eğitim Bilimleri Bölümü

Gönderen : Prof. Dr. Canan Özgen
IAK Başkan Yardımcısı

Canan Özgen

İlgi : Etik Onayı

" "Bilim İletişimi"nin Öğrencilerin Bilim Anlayışına Katkısı: İlköğretim Öğrencileri ve Ebeveyn Algıları" isimli araştırmanız "İnsan Araştırmaları Komitesi" tarafından uygun görülerek gerekli onay verilmiştir.

Bilgilerinize saygılarımla sunarım.

Etik Komite Onayı

Uygundur

06/04/2011

Canan Özgen

Prof.Dr. Canan ÖZGEN
Uygulamalı Etik Araştırma Merkezi
(UEAM) Başkanı
ODTÜ 06531 ANKARA

Ar. Gör. Sevinç Burakgazi
dikkatine
AY 8/4/11

APPENDIX F

THE CONSENT LETTER OF THE MINISTRY OF NATIONAL EDUCATION

ÖĞRENCİ İŞLERİ
DAİRESİ BAŞKANLIĞI
Ev. Ar. Md. Saat:

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

BÖLÜM : İstatistik Bölümü
SAYI : B.08.4.MEM.0.06.22.00-60599/ 36025 05/05/2011
KONU : Araştırma İzni
Sevinç GELMEZ BURAKGAZİ

ORTA DOĞU TEKNİK ÜNİVERSİTESİNE
(Öğrenci İşleri Daire Başkanlığı)

İlgi : a) MEB Bağlı Okul ve Kurumlarda Yapılacak Araştırma ve Araştırma Desteğine Yönelik İzin ve Uygulama Yönergesi.
b) Üniversiteniz Öğrenci İşleri Daire Başkanlığının 29/04/2011 tarih ve 5294 sayılı yazısı.

Üniversiteniz Eğitim Programları ve Öğretim Anabilim Dalı doktora öğrencisi Sevinç GELMEZ BURAKGAZİ'nin **"Bilim İletişimi'nin Öğrencilerin Bilim Anlayışına Katkısı: İlköğretim Öğrencileri, Öğretmen ve Veli Algıları"** konulu tezi ile ilgili çalışma yapma isteği Müdürlüğümüzce uygun görülmüş ve araştırmanın yapılacağı İlçe Milli Eğitim Müdürlüğüne bilgi verilmiştir.

Mühürlü anketler (28 sayfadan oluşan) ekte gönderilmiş olup, uygulama yapılacak sayıda çoğaltılması ve çalışmanın bitiminde iki örneğinin (CD/disket) Müdürlüğümüz İstatistik Bölümüne gönderilmesini rica ederim.

Gülçin UYSAL
Müdür a.
Müdür Yardımcısı

EKLER :
Anket (28 sayfa)

05.05.11* 8281

İl Milli Eğitim Müdürlüğü-Beşevler
İstatistik Bölümü
Bilgi İçin:Nermin ÇELENK
Tel : 223 75 22
Fax: 223 75 22
istatistik06@meb.gov.tr

APPENDIX G

CODING INDEX

SIS in Students Use

1. School Based SIS
   1.1. Teachers
   1.2. Classmates
   1.3. Textbooks
   1.4. Educational Software Products
   1.5. Science Books
2. SIS Beyond School
   2.1. Internet
   2.2. TV
   2.3. Newspapers
   2.4. Science Magazines
   2.5. Families
   2.6. Science Centers/Museums
   2.7. Science Exhibitions
   2.8. Science Camps
3. Directive and Directed SIS

Uses of SIS

Cognitive Needs

Affective Needs

Personal Integrative Needs

Social Integrative Needs

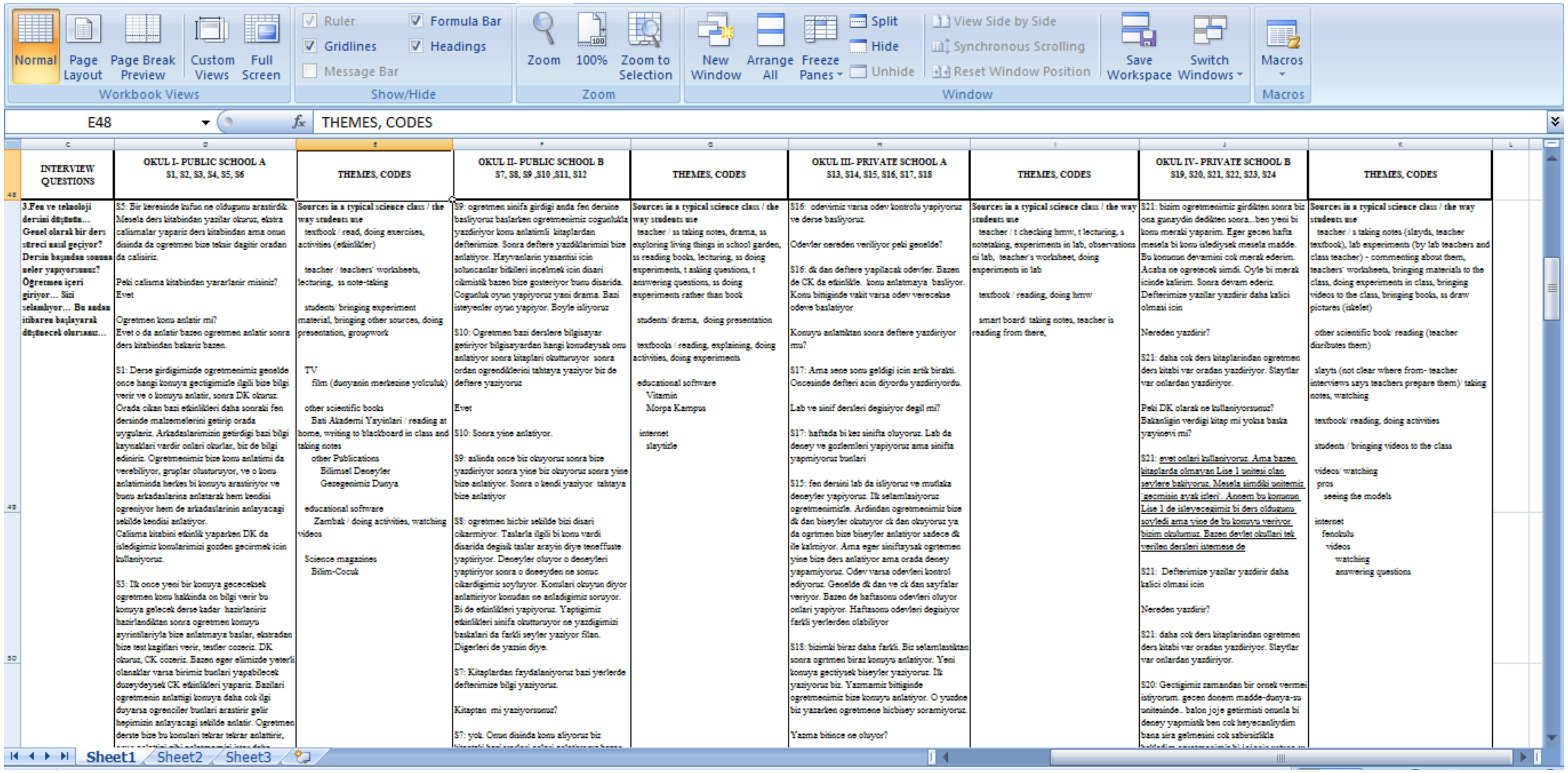
1. Doing Homework/ Project Requirements
2. In Science Classes
3. Preparation for Exams/Tests
4. Conducting Individual Science Related Research

Effective and Ineffective Uses and Features of SIS

1. Accessibility
2. Content Quality
   2.1. Providing Interesting Information
   2.2. Credible
   2.3. Addressing To The Level
   2.4. Providing Permanent Knowledge
   2.5. Updated
   2.6. Relevance To Life
3. Content Presentation
   3.1. Comprehensible
   3.2. Fun – Enjoyable
   3.3. Brief
   3.4. Audio - Visual Support
   3.5. Awakening Curiosity

APPENDIX H

SAMPLE CODED STUDENT FOCUS GROUP INTERVIEW



INTERVIEW QUESTIONS	OKUL I- PUBLIC SCHOOL A S1, S2, S3, S4, S5, S6	THEMES, CODES	OKUL II- PUBLIC SCHOOL B S7, S8, S9 ,S10 ,S11, S12	THEMES, CODES	OKUL III- PRIVATE SCHOOL A S13, S14, S15, S16, S17, S18	THEMES, CODES	OKUL IV- PRIVATE SCHOOL B S19, S20, S21, S22, S23, S24	THEMES, CODES
3.Fen ve teknoloji dersini düşünün... Genel olarak bir ders süreci nasıl geçiyor? Dersin başından sonuna neler yapıyorsunuz? Öğretmen içeri giriyor... Sizi selamlıyor... Bu andan itibaren başlayarak düşünecek olursanız...	S5: Bir keresinde kufun ne oldugunu arastirdik. Mesela ders kitabindan yazilar okuruz, ekstra calismalar yapariz ders kitabindan ama onun disinda da ogretmen bize teksir dagitir oradan da calisiriz. Peki calisma kitabindan yararlanir misiniz? Evet Ogretmen konu anlatir mi? Evet o da anlatir bazen ogretmen anlatir sonra ders kitabindan bakariz bazen. S1: Derse girdigimizde ogretmenimiz genelde once hangi konuya gectigimizle ilgili bize bilgi verir ve o konuyu anlatir, sonra DK okuruz. Orada cikan bazi etkinlikleri daha sonraki fen dersinde malzemelerini getirip orada uygulariz. Arkadaslarimizin getirdigi bazi bilgi kaynaklari vardir onlari okurlar, biz de bilgi ediniriz. Ogretmenimiz bize konu anlatimi da verebiliyor, gruplar olusturuyor, ve o konu anlatiminda herkes bi konuyu arastiriyor ve bunu arkadaslarina anlatarak hem kendisi ogreniyor hem de arkadaslarinin anlayacagi sekilde kendisi anlatiyor. Calisma kitabini etkinlik yaparken DK da isledigimiz konularimizi gozden gecirmek icin kullaniyoruz. S3: Ilk once yeni bir konuya gececeksek ogretmen konu hakkinda on bilgi verir bu konuya gelecek derse kadar hazirlaniriz hazirlandiktan sonra ogretmen konuyu ayrintilariyla bize anlatmaya baslar, ekstradan bize test kagitlari verir, testler cozeriz. DK okuruz, CK cozeriz. Bazen eger elimizde yeterli olanaklar varsa birimiz bunlari yapabilecek duzeydeysek CK etkinlikleri yapariz. Bazilari ogretmenin anlattigi konuya daha cok ilgi duyarsa ogrenciler bunlari arastirir gelir hepimizin anlayacagi sekilde anlatir. Ogretmen derste bize bu konulari tekrar tekrar anlattirir,	**Sources in a typical science class / the way students use** textbook / read, doing exercises, activities (etkinlikler) teacher / teachers' worksheets, lecturing, ss note-taking students/ bringing experiment material, bringing other sources, doing presentation, groupwork TV film (dunyanin merkezine yolculuk) other scientific books Bati Akademi Yayinlari / reading at home, writing to blackboard in class and taking notes other Publications Bilimsel Deneyler Gezegenimiz Dunya educational software Zambak / doing activities, watching videos Science magazines Bilim-Cocuk	S9: ogretmen sinifa girdigi anda fen dersine basliyoruz baslarken ogretmenimiz cogunlukla yazdiriyor konu anlatimli kitaplardan defterimize. Sonra deftere yazdiklarimizi bize anlatiyor. Hayvanlarin yasantisi icin soluncanlar bitkileri incelmek icin disari cikmistik bazen bize gosteriyor bunu disarida. Cogunluk oyun yapiyoruz yani drama. Bazi isteyenler oyun yapiyor. Boyle isliyoruz S10: Ogretmen bazi derslere bilgisayar getiriyor bilgisayardan hangi konudaysak onu anlatiyor sonra kitaplari okutturuyor sonra ordan ogrendiklerini tahtaya yaziyor biz de deftere yaziyoruz Evet S10: Sonra yine anlatiyor. S9: aslinda once biz okuyoruz sonra bize yazdiriyor sonra yine biz okuyoruz sonra yine bize anlatiyor. Sonra o kendi yaziyor tahtaya bize anlatiyor S8: ogretmen hicbir sekilde bizi disari cikarmiyor. Taslarla ilgili bi konu vardi disarida degisik taslar arayin diye teneffuste yaptiriyor. Deneyler oluyor o deneyleri yaptiriyor sonra o deeyden ne sonuc cikardigimiz soyluyor. Konulari okuyun diyor anlattiriyor konudan ne anladigimiz soruyor. Bi de etkinlikleri yapiyoruz. Yaptigimiz etkinlikleri sinifa okutturuyor ne yazdigimizi baskalari da farkli seyler yaziyor filan. Digerleri de yazsin diye. S7: Kitaplardan faydalaniyoruz bazi yerlerde defterimize bilgi yaziyoruz. Kitaptan mi yaziyorsunuz? S7: yok. Onun disinda konu aliyoruz bir	**Sources in a typical science class / the way students use** teacher / ss taking notes, drama, ss reading books, lecturing, ss doing exploring living things in school garden, experiments, t asking questions, t answering questions, ss doing experiments rather than book students/ drama, doing presentation textbooks / reading, explaining, doing activities, doing experiments educational software Vitamin Morpa Kampus internet slaytizle	S16: odevimiz varsa odev kontrolu yapiyoruz ve derse basliyoruz. Odevler nereden veriliyor peki genelde? S16: dk dan deftere yapilacak odevler. Bazen de CK da etkinlikle. konu anlatmaya basliyor. Konu bittiginde vakit varsa odev verecekse odeve basliyor Konuyu anlatiktan sonra deftere yazdiriyor mu? S17: Ama sene sonu geldigi icin artik birakti. Oncesinde defteri acin diyordu yazdiriyordu. Lab ve sinif dersleri degisiyor degil mi? S17: haftada bi kez sinifta oluyoruz. Lab da deney ve gozlemleri yapiyoruz ama sinifta yapmiyoruz bunlari S15: fen dersini lab da isliyoruz ve mutlaka deneyler yapiyoruz. Ilk selamlasiyoruz ogretmenimizle. Ardindan ogretmenimiz bize dk dan biseyler okutuyor ck dan okuyoruz ya da ogrtmen bize biseyler anlatiyor sadece dk ile kalmiyor. Ama eger siniftaysak ogrtemen yine bize ders anlatiyor ama orada deney yapamiyoruz. Odev varsa odevleri kontrol ediyoruz. Genelde dk dan ve ck dan sayfalar veriyor. Bazen de haftasonu odevleri oluyor onlari yapiyor. Haftasonu odevleri degisiyor farkli yerlerden olabiliyor S18: bizimki biraz daha farkli. Biz selamlastiktan sonra ogrtmen biraz konuyu anlatiyor. Yeni konuya geciyorsak biseyler yaziyoruz. İlk yaziyoruz biz. Yazmamiz bittiginde ogretmenimiz bize konuyu anlatiyor. O yuzden biz yazarken ogretmene hicbisey soramiyoruz. Yazma bitince ne oluyor?	**Sources in a typical science class / the way students use** teacher / t checking hmw, t lecturing, s notetaking, experiments in lab, observations ni lab, teacher's worksheet, doing experiments in lab textbook / reading, doing hmw smart board/ taking notes, teacher is reading from there,	S21: bizim ogretmenimiz girdikten sonra biz ona gunaydin dedikten sonra...ben yeni bi konu meraki yaparim. Eger gecen hafta mesela bi konu islediysek mesela madde. Bu konunun devamini cok merak ederim. Acaba ne ogretecek simdi. Oyle bi merak icinde kalirim. Sonra devam ederiz. Defterimize yazilar yazdirir daha kalici olmasi icin Nereden yazdirir? S21: daha cok ders kitaplarindan ogretmen ders kitabi var oradan yazdiriyor. Slaytlar var onlardan yazdiriyor. Peki DK olarak ne kullaniyorsunuz? Bakanligin verdigi kitap mi yoksa baska yayinevi mi? S21: evet onlari kullaniyoruz. Ama bazen kitaplarda olmayan Lise 1 unitesi olan seylere bakiyoruz. Mesela simdiki unitemiz 'gecmisin ayak izleri'. Annem bu konunun Lise 1 de isleyecegimiz bi ders oldugunu soyledi ama yine de bu konuyu veriyor bizim okulumuz. Bazen devlet okullari tek verilen dersleri istemese de S21: Defterimize yazilar yazdirir daha kalici olmasi icin Nereden yazdirir? S21: daha cok ders kitaplarindan ogretmen ders kitabi var oradan yazdiriyor. Slaytlar var onlardan yazdiriyor. S20: Gectigimiz zamandan bir ornek vermei istiyorum. gecen donem madde-dunya-su unitesinde.. balon joje getirmisti onunla bi deney yapmistik ben cok heyecanliydim bana sira gelmesini cok sabirsizlikla	**Sources in a typical science class / the way students use** teacher / s taking notes (slayds, teacher textbook), lab experiments (by lab teachers and class teacher) - commenting about them, teachers' worksheets, bringing materials to the class, doing experiments in class, bringing videos to the class, bringing books, ss draw pictures (iskelet) other scientific book/ reading (teacher disributes them) slayts (not clear where from- teacher interviews says teachers prepare them)/ taking notes, watching textbook/ reading, doing activities students / bringing videos to the class videos/ watching pros seeing the models internet fenokulu videos watching answering questions

APPENDIX I

SAMPLE CODED TEACHER INTERVIEW

I: Peki öğrencileriniz TV`den bilimsel bilgiye ulaşmak amacıyla yararlanırlar mı?**  T: Özellikle canlılar dünyasını cok merak ediyorlar. Canlıları tanıma açısından çok etkili olduğunu düşünüyorum. NG`de de böyle programlar var. Onun dışında da bilimsel içerikli çok fazla bilindik bir kanal çocukların izlediği. **I: TV diğer kaynaklara göre hangi yönlerden farklı olabilir? T: TV`de merak ettiği konuya istediği an ulaşamıyor. Mesela internetten sürekli ulaşabiliyor. **I: Öğrencileriniz bilimsel dergi okurlar mı Bilim Çocuk gibi NGK gibi?** Bilim Çocuk takip ediyorlar NGK okuyan da var. Ama onun sayısı az. O konuda illa şunu da alın demiyorum. Bilim Çocuğu takip etmelerinin en önemli nedeni benim zorunlu kılmam. Yani bu zamana kadar ben zorunlu kıldığım için takip ettiler. Bundan sonrasında takip ederler mi işte onu bilmiyorum. Benden çıktılar artık çocuklar. 6. Sınıfa geçtiler. 2. ya 3. sınıfta başlattım. 3-4 sene boyunca amacım cocukların bilimsel konulara karşı ilgisini uyandırmak doğru kaynaklara yönlendirmek doğru bilgiler edindirmek ve bu bilgileri de paylaşmak. O yüzden çocuklara Bilim Çocuk dergisinde en beğendiğiniz konu neyse o konuyla ilgili bir sunu yapın sunum hazırlayın kimileri bilgisayardan hazırladı kimi sözel olarak paylaştı...bu bilgileri paylaştılar. Çocukların hangi konulara ilgi duyduğunu öğrenmeye çalıştım işte canlılar mı bitkiler mi uzay mı deniz altı mı deniz dünyası mı onu merak ettim. Hem de dediğim gibi paylaşım en önemli unsur. Bilgi edinilmeli ama bilgi paylaşılmalı.	**TV** **Use** Individual Science Research **How** Watching **Effective** Visuality **Ineffective** Difficult to access science **Internet** **Effective** Easy to access science **Teacher** **How** Directing /Dir. Source Guiding Awakening curiosity **Science Magazines** **How** Sharing in the class

APPENDIX J

SAMPLE CODED PARENT INTERVIEW

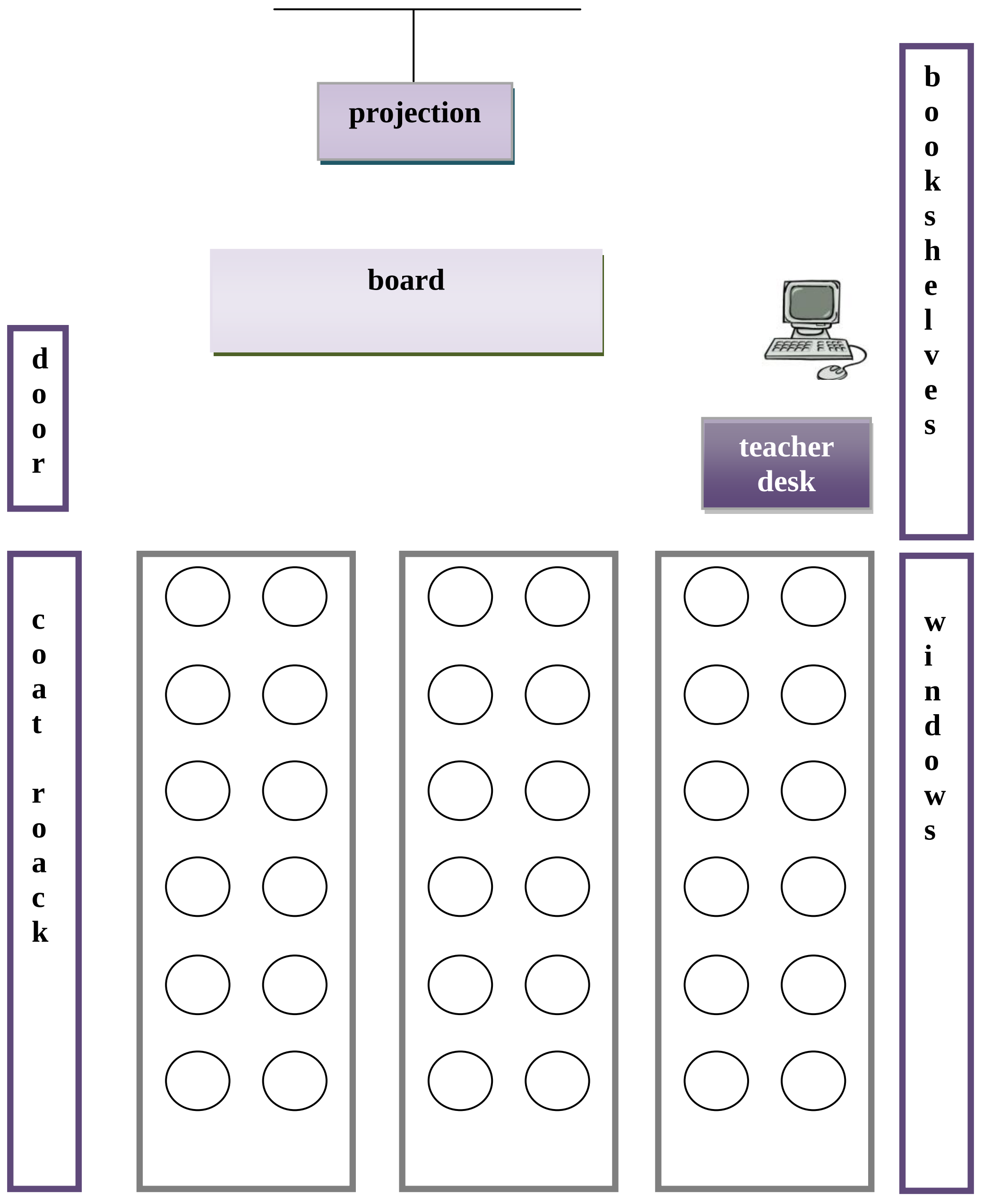
velileri ilgilendiren sorular bir kısmı doğrudan doğruya çocukların içinde bulunduğu sistemle ilgili sorular cevap vermekte bile zorlanıyorum. Ama kişisel kanaatim dersem eğitim sistemi maalesef berbat bir seviyede yükselecek bir noktada değil. Bu da bilinçli olarak bu noktaya getiriliyor. Öğretmenler artık anne babaların çocuklara olan aşırı ilgisi ve düşkünlüğünden ötürü bunu bir rant kapısı haline dönüştürüyor. Derste ders anlatılmıyor özel derslerde özel kurslarla birtakım diğer imkanlarla bunu tamamen ranta tabi tutarak yönlendirme eğilimi var.	**<u>Parents</u>** **How** Changing roles- Parents--Teachers
Aslında müfredata bağlı kalınırsa eğitim son derece basitleştirilebilir. Müfredat kitaplara bakıyoruz ilköğretim 1. basamak eğitimine bakıyoruz olması gereken seviye. Ama yardımcı kaynak olarak sunulan ya da ilave test kitaplarına baktığınızda ya da daha önce de söyledim ilave SBS sınavlarında çıkan sorulara baktığınızda inanılmaz farklı bir boyut var. Çocuklar, ebeveynler ikilem içerisindeler. İlköğretim 5. sınıfa giden çocukların ana babası halen sabahtan akşama kadar okulun bahçe duvarında oturmaktan keyif alıyor. Bunu gören eğitimcilerimiz de	**<u>Textbooks</u>** **Ineffective** Does not support high stakes exams
sağolsun topu artık anne babaya atıyor. Şunu duymaktan biz artık sıkılıyoruz annenize babanıza söyleyin konuyu size anlatsın. Anne baba artık model rol değiştirdi öğretmen olmaya başladı. Çocuk üzerindeki eğitim sürecini daha olumsuz hale getirdi. Eğitimci değilim ama takdir edersiniz ki herkes rolünü oynamak zorunda.	**<u>Teachers</u>** **Ineffective** Problems in guidance
I. Peki çocuğunuz anne-babası olarak size bilimsel bilgi edinme hususunda danışır mı? P. Danışır ama bu etkili olmaz. Çünkü bence çocuk kendi akranlarıyla kendi arkadaşlarıyla bulunduğu ortamda öğrenebilir eğitilebilir anne baba rolüyle öğretmen rolü çok farklıdır. Formal anlamda eğitimden bahsediyorum. Yoksa eğitimi çok geniş soluklu olarak algılıyorum	**<u>Classmates</u>** **Effective** Same age group/ Context

APPENDIX K

SAMPLE CODED CLASSROOM OBSERVATION FIELDNOTES

OBSERVATION-16

Date: 05/16/2011
School: Public School B
Class: 5C
Course: Science and Technology - Fen ve Teknoloji
Unit: Let`s Learn about World of Living Things - Canlılar Dünyasını Gezelim Tanıyalım
Subject: Fungies
Duration: 40 min
Class Size: 36



<table>
<tr><th>OBSERVATION NOTES</th><th>CODES</th></tr>
<tr><td>
09:50 Ders başladı.

T: Şimdi geçen hafta arkadaşımız sınıfa mantar getirmişti incelemiştik.
Mantarın özellikleri nelerdi?
Mantar bir bitki miydi?
(Soru- cevap yoluyla dersi ilerliyor)
Öğretmen tahtaya iki şekil çizdi:
1. Mantarın şapka ve sap kısımlarını gösterir şekil
2. Çiçeğin “çiçek yaprak gövde kök” kısımlarını gösterir şekil

09:55 Öğretmen ders kitabında sayfa 173`te “Elif’in Rüyası” adlı kısmın okunmasını istedi. İlgili kısmı okumak için parmak kaldıran bir öğrenciye öğretmen söz verdi. Öğrenci okumaya başladı.

(öğrenciler kitaplarından takip ediyor)

(Konunun sonunda bir soru var)

“Elif’in rüyasında konuştuğu mantarı bitkiden ayıran özellikler nelerdir?”

T: Şimdi bu soruya bir cevap verelim.

(öğrenciler parmak kaldırıp söz hakkı aldılar ve çeşitli cevaplar verdiler, öğretmen bunların üzerine eklemeler yaptı.)

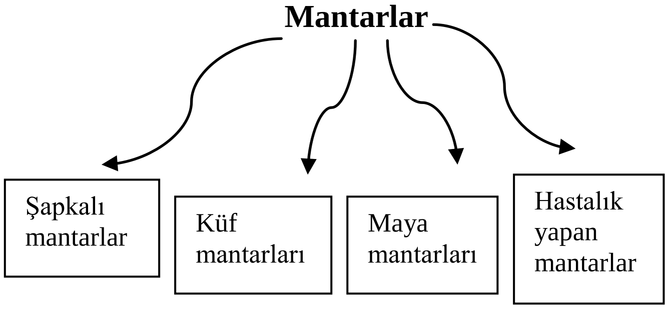
Bir öğrenci öğretmenine bir dergi getirdi (National Geographic Kids). Öğretmen, öğrencinin getirdiği derginin bu ay “mantarlar” konusunu ele aldığını söyledi ve dergiden bir mantar şeklini tüm sınıfa gösterdi.

10:00 (Öğretmen mantarların zehirli etkilerine karşı sınıfı uyardı)

T: Kültür mantarlarını yememiz daha emniyetlidir.
</td><td>
Teacher
- Reminding
- Strenghtning the subject with daily life examples
- Questioning

Textbook
- Reading
- Answering the questions

Scientific magazines
- Sharing the things learned
- Pictures
</td></tr>
</table>

10:05 T: Kitabımızdan okumaya devam edelim. Oku bakalım (bir öğrenciyi işaret ederek) (DK sf 174 te mantarlar ile ilgili kısmı bir öğrenci okumaya başladı)	**Teacher** - Informing - Directing **Textbook** - Reading
Okumanın ardından öğretmen tahtaya bir şekil çizdi:  	**Teacher** - Informing
T: Şimdi bu şekli defterinize çizin sonra deftere özetleyeceğiz. S: Neden? T: Nedenini bilmiyor musun? S: Ünite sonunda yazılır özet ama (öğretmen sustu) S2: Öğretmenin kültür mantarını niye yazmadınız? T: O bu kapsama girmiyor (!) Ss: (hep bir ağızdan birkaç öğrenci) O da şapkalı mantar kapsamında değil mi? (öğretmen sustu)	**Teacher** - Questioning
10:05 T: Evet susun şimdi yazıyoruz (öğrenciler öğretmenin kaynak kitaptan yazdırdığı bilgileri yazmaya başladı:) - Mantarlar bitki değildirler. - Bitkiler kendi besinlerini yapabilirler ama mantarlar kendi besinlerini yapamazlar. 10:12 T: Şimdi şapkalı mantarları açıklıyoruz	**Other scientific books** - Taking notes **TV** - Up-to-date information - Acquisition of information

APPENDIX L

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Volume:	30
Issue:	2

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APPENDIX N

TURKISH SUMMARY

TÜRKÇE ÖZET

BİLİM İLETİŞİMİNDEN FEN EĞİTİMİNE YANSIMALAR: 4. ve 5. SINIF ÖĞRENCİLERİNİN ÇOK BOYUTLU BİLİMSEL BİLGİ KAYNAKLARI ÜZERİNE BİR OLGUBİLİM ÇALIŞMASI

I. GİRİŞ

Farklı öğrenme ortamlarında (okula dayalı ve okul dışı ortamlar), çeşitli kaynaklar (medya kaynakları, bilim merkezleri/müzeleri) aracılığı ile bilimsel bilgiye erişiriz (Falk, Donovan, & Woods, 2001). Formal anlamda programa dayalı öğrenmeler çoğunlukla okul ortamında başlar, okul dışı ortamlarda ise, medya kaynakları fen öğrenimine büyük ölçüde katkı sağlar (Brossard & Nisbet, 2007).

Günümüzde okul, nüfusun büyük bir çoğunluğunun ilk kez düzenli ve resmi fen öğrenimi ve öğretimiyle karşılaştığı kurum olarak düşünülmektedir (Negrete & Lartigue, 2004). Fen eğitimi, öğrencilerin bilimsel gerçekleri ve bilimsel sonuçları (örn. kavramlar, teoriler, kanunlar, modeller) öğrenmelerinde önemli rol oynar. Diğer bir deyişle, fen eğitiminin bilimsel bilgiyi kitlelere ulaştırma hususundaki misyonu önemlidir. Miller (2004), bireylerin fen anlayışlarının, kişilerin temel kavramları ve yapıları anlayışlarına bağlı olarak değişkenlik gösterdiğini iddia etmektedir. Eğitim burada, bireylerin gelecekteki yaşamlarındaki bilgi oluşumları için adeta bir katalizör görevi görmektedir (Neuman, 1981; Tichenor, Donohue, & Olien, 1970). Eğitimli bireyler, fen eğitimi ya da başka özel bir alana ithaf edilmeksizin, bilimsel otoriteye saygı duyma hususunda daha düşük seviyede eğitimli bireylere nazaran bilime karşı daha olumlu bir tutum sergilemektedirler (Brossard & Nisbet, 2007). Öyleyse, eğitim, bilime karşı duyulan saygıyla oldukça yakından ilgilidir. Miller'e (2004) göre, toplumun büyük bir çoğunluğu, bilimsel konulardaki temel kavram ve anlayışlarında, aldıkları eğitime güvenmektedirler. Buna ek olarak, çocukluk döneminde, neyin, ne şekilde öğretildiği, bireyin yetişkin yaşamında bu konuya bakış açısında büyük ölçüde belirleyici niteliktedir (House of Lords, 2000).

Çocukluk döneminde edinilen fen deneyimlerinin yetişkinlik döneminde bilimsel aktivitelere katılımlar üzerine etkisi, fen eğitimi ve bilim iletişimi alanlarındaki araştırmacıların ilgilendikleri temel konular arasındadır (Bell, Lewenstein, Shouse, & Feder, 2009; Brossard & Nisbet, 2007; Elsley & McMellon, 2010; Osborne, Collins, & Simon, 2003; Oskala, Keaney, & Bunting, 2009).

Yetişkinlerden toplanan verilere göre, çocukluk döneminde okul dışı etkinliklere katılım, yetişkinlik dönemindeki katılım üzerinde uzun dönemli bir etkiye sahiptir (Elsley & McMellon, 2010). Bunun yanı sıra, Oskala, Keaney ve Bunting (2009) çocukluk dönemi deneyimlerinin yetişkin katılımına etkilerini araştırdıkları çalışmalarında, yine bu iki değişken arasında yüksek oranda bir ilişki tespit ettiler. Diğer bir çalışmada, Falk ve Dierking (2010) sadece yetişkinlik dönemi okul dışı öğrenme etkinliklerinin değil, aynı zamanda çocukluk dönemindeki okul dışı öğrenme deneyimlerinin de yetişkinlerin bilimsel düzeyine anlamlı ölçüde katkısı olduğunu iddia etmektedir. Bu katkıda okul temelli eğitimin rolü, okul dışı fen öğrenme etkinliklerine nazaran oldukça geri planda kalmaktadır.

Bu çalışma, yukarıda sunulan araştırmalar ışığında, dört temel veri kaynağına dayanmaktadır. İlk olarak, çocukluk dönemi deneyimlerinin yetişkinlik dönemi bilimsel etkinliklere katılımdaki payının önemli ölçüde büyük olması; ikinci olarak, 4. ve 5. sınıf düzeylerinin fen eğitiminde "kritik yaş düzeyi" olarak adlandırılması; üçüncü olarak, ulusal ve uluslararası sınavlarda, fen alanında Türk öğrencilerinin düşük performans sergilemeleri; son olarak da farklı kaynakların ve öğrenme ortamlarının fen öğrenimini desteklemek üzere birlikte kulanılmasıdır. Bu amaçla, öğrencilerin, öğretmenlerinin ve ebeveynlerin görüşleri doğrultusunda, 4. ve 5. sınıf öğrencilerinin okul içi ve okul dışı kaynakları kullanımlarının derinlemesine irdelenmesi, fen öğreniminde kullanılabilecek olası kaynakların bütününün bir resmini sunması açısından alana katkı sağlayacaktır.

Bilim iletişimi, alanyazında Amerika ve İngiltere'de yüksek öncelik taşımasına rağmen, hâlâ, fen eğitimi ve bilim iletişimini birlikte ele alan çalışma sayısı oldukça sınırlıdır. Türkiye odaklı içerikte, bu bağlamda sınırlı sayıda çalışma olması bir yana, bilim iletişimi kavramı da iyi bilinmemektedir (Arca, 2004). Fen öğrenimi alanına yeni yaklaşımlar getirmek üzere, okul çağındaki öğrencilerin çeşitli kaynakları kullanımları, ilgileri ve bu kaynakları etkili ve etkisiz kılan özelliklerin daha ileri ve derinlemesine incelenmesine ihtiyaç duyulmaktadır.

1.1. Çalışmanın Amacı

Kavramsal çerçevesini fen eğitimi ve bilim iletişimi çalışmaları üzerine inşa eden bu çalışma, 4. ve 5. sınıf öğrencilerinin fen öğreniminde çeşitli kaynakları kullanımlarını incelemektedir. Çalışmanın temel amacı, öğrencilerin, velilerin ve öğretmenlerin, öğrencilerin bu kaynakları fen öğreniminde kullanımları, kaynakların özellikleri, ve etkinlikleri üzerine görüşlerine odaklanarak okul içi ve okul dışı kullanımda olan anlamlı fen öğrenme kaynaklarını tanımlamaktır.

Bu amaç doğrultusunda çalışmanın temel araştırma soruları şunlardır:

(1) 4. ve 5. sınıf öğrencilerinin fen öğreniminde kullandıkları kaynaklar nelerdir?

(2) Öğrenciler, bilimsel bilgi kaynaklarından fen öğreniminde nasıl ve ne şekilde yararlanmaktadır?

(3) Bilimsel bilgi kaynaklarını öğrencilerin fen öğreniminde etkili ya da etkisiz kılan özellikler nelerdir?

1.2. Çalışmanın Önemi

Bilim, hayatımızın hemen her yanını çevrelemiştir. Buradan hareketle, bilimin bilgisine çok çeşitli ortamlar ve kaynaklar vasıtasıyla erişmek mümkündür. Bu kaynakların kullanımları ve amaçları ortamdan ortama farklılık göstermektedir. Yetişkinlerin, çeşitli kaynakları bilimsel bilgiye erişim amacıyla kullanımlarını inceleyen çalışmalar mevcuttur (Science and Engineering Indicators, 2012). Bununla birlikte, çocuklarda bu süreçlerin nasıl işlediğine dair daha az araştırma bulunmaktadır. Fen eğitimi ve bilim iletişimi çalışmalarına dayanan ve iki disiplini de aynı ölçüde ilgilendiren bu çalışma, 4. ve 5. sınıf öğrencilerinin bilimsel bilgi kaynaklarını kullanımı, okul içi ve okul dışı öğrenme ortamları ve kaynakları (TV, internet, gazete, dergi, kitap, anne-baba, öğretmen, akranlar, bilim merkezleri ve müzeleri, bilim sergileri, bilim kampları, vb.), ve bu kaynakları fen öğreniminde ilginç, eğlenceli, ve cazip kılan özellikleri incelemektedir. Anlamlı fen öğrenme kaynaklarını incelemek ve okul içi-dışı bu kaynaklar vasıtasıyla öğrenme süreçlerini daha iyi tanımlamak için öğretmenlerin ve velilerin görüşlerine de başvurulmuştur. Bu doğrultuda, çalışmanın, her iki disiplinde de araştırmalar yürüten, fen eğitimi ve bilim iletişiminin dinamiklerini değiştirmek isteyen araştırmacılara, bilimsel bilgi kaynaklarının niteliğini arttırmak ve öğrencilere daha kaliteli fen öğrenme ortamları sunmak üzere gayretlerini birleştirebilecekleri yeni perspektifler ve yaklaşımlar önermesi beklenmektedir.

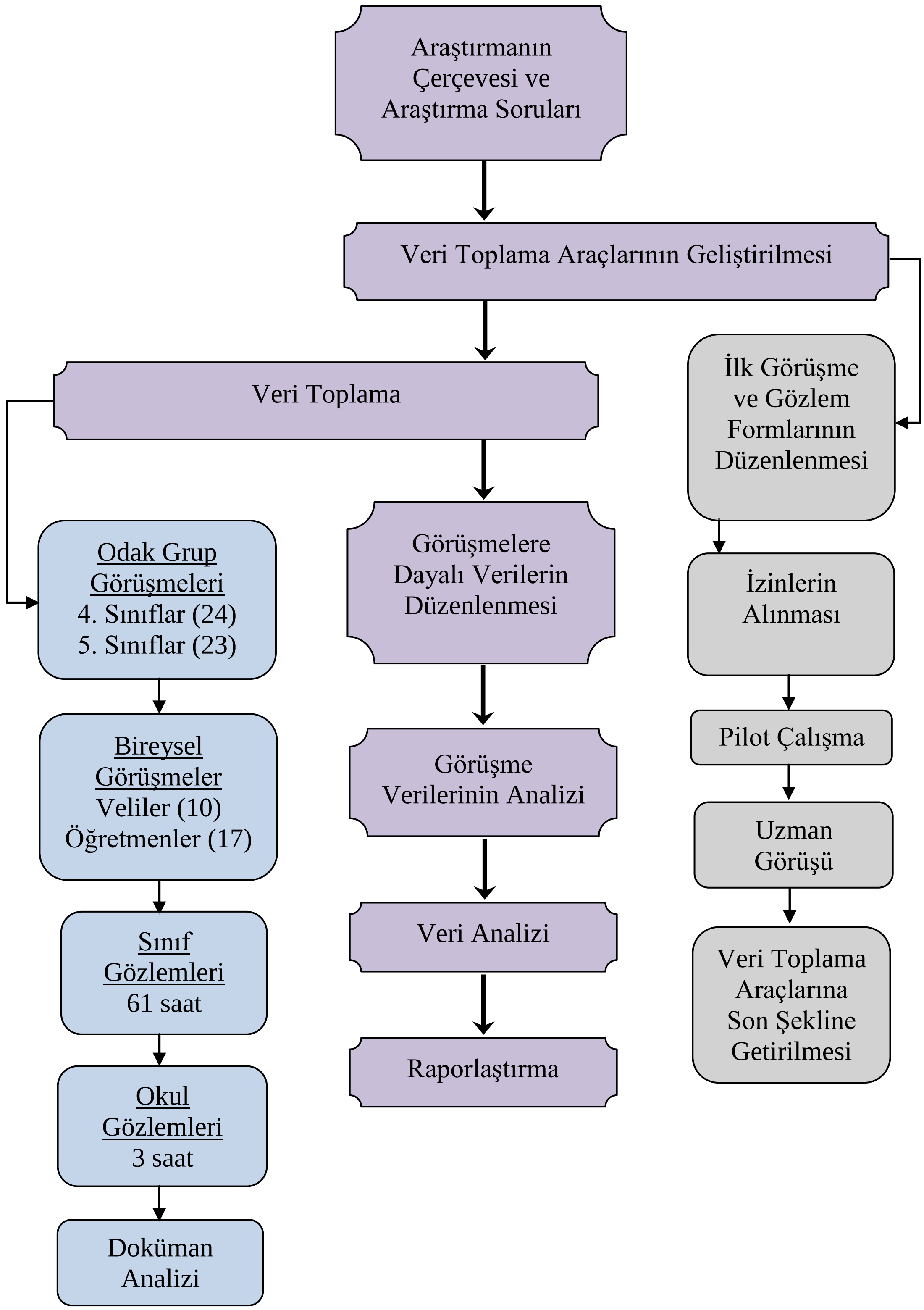
Okul çağındaki çocuklarda fene karşı ilgideki azalma (Baykul, 1990; Breakwell & Beardsell, 1992; Buluş-Kırıkkaya, 2011; Catsambis, 1995; Chapman, 1997; Gilbert, 2008; Hofstein & Welch, 1984; Piburn & Baker, 1993; Pell & Jarvis, 2001; Sorge, Newsom, & Hagerty, 2000; Weinburgh, 1998); fen eğitimini 21. yüzyılın koşullarına adapte etme; fen eğitiminde karşılaşılan aksak yönler (Appelbaum & Clark, 2001; Blades, 2001; Gilbert, 2008) yetersiz sayıda öğretmen, aşırı kalabalık sınıflar, sınava dayalı değerlendirme, diğer disiplinlerle ilişki kopuklukları, ve yetersiz fiziksel koşullar (Özden, 2007); ve bilim iletişiminde karşılaşılan ve okullardaki fen eğitimi ile ilgili sorunlar, araştırmacıyı böyle bir çalışma yapmaya yönlendiren etmenlerdendi. Stocklmayer (2001; s.144) tarafından da örneklendirildiği üzere: “Konular [fen] daha iyi öğretilmiş olsaydı [okullarda]…toplum hakkında bu kadar kaygılanmak zorunda kalmazdık”. Buradan hareketle, araştırma, bilim iletişiminin fen eğitimine olası yansımalarından yola çıkmaktadır.

Bilime karşı saygıyı yerleştirmek, ya da insanları bilim çevrelerinde yaşanan değişimler hakkında bilgilendirmek için en etkili yollar alanyazında geniş yer tutmaktadır (Brossard & Nisbet, 2007). Geleceğimizin önemli bir parçası olan çocuklar, fen eğitimi ve bilim iletişimi çalışmalarında başrolde olsa da, özellikle bilim iletişimi konusundaki çalışmalarda doğrudan bu yaş grubuna yönelik araştırma oldukça sınırlıdır. Bu doğrultuda, öğrencileri fen alanına karşı teşvik etmek ve ilgilerini arttırmak için bilinen fakat farkında olunmayan kaynakların önemi vurgulanabilir. Bu çalışma ayrıca, "bilimsel bilgiye erişim" hususunda bilinen fakat farkına varamadığımız yolları da ortaya çıkarma amacı gütmektedir. Alanyazında, onlarca yıldır örgün ve yaygın eğitim arasındaki ilişkiye ve etkileşime yönelik tartışmalar süregelmektedir. Fen eğitimi ile bilim iletişimi arasındaki ilişkiyi inceleyen araştırma sayısı ise oldukça sınırlıdır. Buna ek olarak, çalışma, bilim iletişimi kaynaklarını, fen eğitimi ile bilim iletişimini ilişkilendiren bir yaklaşımla ele alarak incelemesi açısından diğerlerinden farklılaşmaktadır. Alanyazındaki önemli bir açığı kapatma gayreti içinde olan çalışmanın, fen bilgisi öğretmenlerini, eğitimcileri, araştırmacıları, medyayı, bilim merkezi yetkililerini ve MEB' i fen eğitimini güçlendirmek için farklı kaynakların işe koşulması açısından teşvik etmesi beklenmektedir.

II. YÖNTEM

Bu çalışmanın amacı, 4. ve 5. sınıf öğrencilerinin fen öğreniminde kullanımında olan anlamlı kaynakları "ne" ve "nasıl" soruları doğrultusunda tanımlamak ve bu kaynakları etkili ve etkisiz kılan özellikleri ortaya çıkarmaktır. Bilimsel bilgi kaynaklarını temel alan çalışma, aynı zamanda fen eğitimi ve bilim iletişimini, her iki alanın da öne çıkan kaynakları doğrultusunda ilişkilendirmektir.

Söz konusu hedefleri gözönüne alarak, bireylerin bu konudaki deneyimlerini ve anlayışlarını incelemek için derinlemesine görüşmelerden yararlanılmıştır. Buradan hareketle, çalışma nitel araştırma ilkelerine dayandırılmıştır. Nitel çalışmalar, ilişkiler, eylemler, durumlar, ya da materyallerin bütünsel etkilerini (Fraenkel & Wallen, 2006), olaylar ve olgular hakkında daha derinlemesine bilgi edinmek amacıyla bireylerin yükledikleri anlamlar doğrultusunda yordayarak inceler (Denzin & Lincoln, 2005; Yıldırım & Şimşek, 2008). Çalışmanın dizaynı, Şekil 1`de sunulmaktadır.



Şekil 1. Çalışma planı

Nitel yöntembilimi, veriyi bireylerin kendi yazılı ya da sözlü ifadeleri ve gözlenebilir davranışları doğrultusunda tanımlayan araştırma süreçleridir

(Bogdan & Taylor, 1975). Çalışmada nitel yaklaşımların kullanılmasında Creswell (1998) tarafından da açıklandığı üzere birtakım gerekçeler mevcuttur. Öncelikle, araştırma soruları nitel çalışma yöntemlerine uygunluk göstermektedir; ikincisi, öğrencilerin fen öğreniminde kullandıkları bilimsel bilgi kaynaklarını, etkili ve etkisiz özelliklerini ve süreçleri derinlemesine tanımlamaya yönelik bir çalışmaya ihtiyaç duyulmaktadır. Bu amaçla, 10-12 yaş grubu öğrencilerinden derinlemesine veri toplamanın nitel araştırma yöntemleriyle gerçekleştirilebileceği düşünülmüştür. Son olarak, araştırmacı derinlemesine veri toplamak ve sonrasında yazılı metinlerde ayrıntılı analizleri yürütebilmek için yeterli zaman ve koşullar oluşturmuştur. Belirtilen nedenler ışığında, çalışmada tam anlamıyla nitel araştırma süreçleri takip edilmiştir.

2.1. Olgubilim Çalışması

Nitel araştırma desenlerinden biri olan olgubilim yaklaşımını kullanan bu çalışmanın amacı bireylerin araştırma soruları ile ilgili olarak “neyi,” “nasıl” yaşadıklarını ortaya çıkarmaktır (Creswell, 2007; Moustakas, 1994). Sosyal bilimleri etkileyen iki temel kuramsal yaklaşımdan biri olan olgubilim yöntemi (Bogdan & Taylor, 1975), felsefi ve psikolojik temellerde bir grup insanın yaşadığı deneyimlerin özünü ve yapısını incelemektedir (Denzin & Lincoln, 1994; Patton, 1990; Welman & Kruger, 1999; Yıldırım & Şimşek, 2008).

Patton’a (1990) göre, tarafsız ya da bağımsız bir gerçeklik yoktur, sadece kişisel gerçeklik vardır. Bu nedenle, “olgubilimci, insan davranışlarını aktörlerinin kendi düşünce çerçevelerinden anlamlandırmaya çalışır” (Bogdan & Taylor, 1975, s.2). Bu doğrultuda, olgubilimin temeli, incelenen durumla ilgili olayın aktörlerinin tüm tanımlarını kayıt altına almaktır (LeCompte, Millroy & Preissle, 1992). Olgu, burada, alışılageldik fakat anlamları çok da açık olmayan deneyimler, anlayışlar, algılar veya duygular olabilir (Yıldırım & Şimşek, 2008).

Bu çalışmada, “öğrencilerin fen öğreniminde farklı kaynakları kullanımı” olgusundan yola çıkarak, öğrencilerin fen öğreniminde farklı kaynaklardan yararlanması, bu kaynakları kullanım şekilleri ve bu kaynakların özellikleri gibi hususlar incelenmektedir. Bilimsel bilgi kaynakları yoluyla fen öğrenimi olgusunu tüm ayrıntılarıyla derinlemesine resmetmek ve bulguları geçerli kılmak amacıyla, farklı veri kaynaklarından (öğrenciler, veliler, ve öğretmenler), veri toplama araçlarından (görüşmeler, gözlemler, ve doküman analizi), farklı kuramlardan (yerleşik öğrenme kuramı, kullanımlar ve memnuniyetler kuramı), ve araştırmacılardan (araştırmacının kendisi ve danışmanları) yararlanılmıştır.

2.2. Veri Kaynakları

Çalışmada kullanılan örnekleme stratejisi iki aşamalıdır. İlk aşamada, temsili bir örnekleme erişmek için iki devlet okulu ve iki özel okul, kolay ulaşılabilir örnekleme yoluyla Ankara ilinden seçilmiştir. Aynı ilçede birbirine yakın okulların araştırma okulu olarak seçilmesi, zamandan tasarruf sağlaması yanında (Marshall, 1996) dört okulda birbirine paralel gözlemlerin yürütülebilmesi açısından da anlamlı olmuştur.

İkinci aşamada, katılımcılar belli bir ölçüte bağlı olarak (Creswell, 1997) araştırılan olguyu yaşamış bireyler arasından seçildiler. (Kruger, 1988). Hycner'e göre (1999, s. 156) "olgu, buna katılımcılar da dahil olmak üzere, yöntemi belirler (ya da tam tersi)." Bu doğrultuda, çalışmada örneklem seçiminde kullanılan yöntem, Patton (1990, s.169) tarafından da tanımlanan amaçlı örneklemedir: "Amaçlı örneklemede araştırmacılar, katılımcıları, kasıtlı olarak bilgi açısından zengin bireylere ve çalışma alanlarına ulaşmak için seçerler".

Katılımcıların seçiminde ise, birden çok ölçüt kullanılmıştır. Öncelikle öğrencilerin seçiminde, ölçütler şunlardır: (1) 4. veya 5. sınıf öğrencisi olmak, (2) fen bilgisi konularına karşı ilgili olmak. Creswell'e göre (1997) amaçlı örneklemeler, olgubilim çalışmaları ile oldukça uyumlu işlev görmektedir.

Çalışmada, öğrencilerin yaş aralığı 10-12 arasında ayrılmıştır. 5. sınıf düzeyinden 23 öğrenci (14 Kız, 9 Erkek) odak grup görüşmelerine katılırken, 4. sınıf düzeyinden ise 24 öğrenci (12 Kız, 12 Erkek) görüşmelere katılmıştır. Tüm öğrencilerin evde ve okulda internet erişimi mevcut olmakla birlikte, özel okul öğrencileri, okuldaki bilgisayarlardan internete erişme hususunda devlet okullarındaki yaşıtlarından daha çok imkana sahip olmuşlardır. Buna ek olarak, devlet okullarında öğrencilerin kullanımlarına açık fen laboratuarları bulunmazken, özel okullarda fen laboratuarı için fen derslerinin bir parçası olarak bir süre ayrılmaktaydı.

Çalışmanın ebeveyn katılımcıları, 2010-2011 bahar döneminde çocuğu 4. ya da 5. sınıf düzeyinde okuyan veliler arasından seçilmiştir. Bunun için, dört okuldaki 4. ve 5. sınıf öğrencilerine çalışma ile ilgili bilgilendirici bir form dağıtılmıştır. Bu form yoluyla, veliler, sözkonusu araştırma, çalışma süreci ve bu sürece olası katkıları hususlarında bilgilendirilmişlerdir. Formun sonunda, velilerden, çocuklarının bilimsel bilgi kaynakları vasıtasıyla fen öğrenmeleri üzerine yapılacak görüşmeye katılımları hususunda görüş rica edilmiştir. Formu imzalayıp katılım isteklerini sunan 15 veliden iletişim bilgileri kısmını da dolduran 10 veli araştırmaya dahil edilmiştir. Velilerin yaş düzeyi 35-50 arasında olup, büyük çoğunluğu üniversite düzeyinde eğitim seviyesine ve mesleğe sahiptiler. Ailelerin büyük çoğunluğunun aylık geliri 3000 TL ve üzerinde olduğu belirtilmiştir.

Son olarak, okullardaki tüm 4. ve 5. sınıf düzeyindeki öğretmenlerden çalışmaya katılmaya gönüllü olanlar, araştırmanın öğretmen katılımcılarını oluşturmuştur. Devlet okullarından farklı olarak, özel okullarda fen derslerini fen ve teknoloji branş öğretmenleri yürütmüş, bu nedenle özel okullarda sınıf öğretmenleri yerine, fen ve teknoloji dersi branş öğretmenleri araştırmaya dahil edilmiştir. Öğretmenlerin yaş aralığı 29 ve 55 arasında değişkenlik göstermektedir. Devlet okulu öğretmenlerinin yaş aralığı (38-55), özel okul öğretmenlerinin yaş aralığından (29-38) daha düşük olduğu ortaya çıkmıştır. Öğretmenler, 2-35 yıl arasında öğretmenlik deneyimine sahip olduklarını belirtmişlerdir. Dört öğretmen dışında, geriye kalan 13 öğretmenin, eğitimini aldıkları alanda görev yaptıkları anlaşılmıştır.

2.3. Veri Toplama Araçları

Olgubilim çalışmalarının doğasına uygun olarak, araştırmada, yarı yapılandırılmış anket formları temel veri toplama araçları olarak kullanılmıştır (Yıldırım & Şimşek, 2008). Buna ek olarak, çalışma, gözlemler ve araştırma soruları çerçevesinde dokümanlar ile de desteklenmiştir. Veri toplama araçları, derinlemesine alanyazın taramasına dayalı olarak araştırmacı tarafından öğrenciler için (odak grup görüşmeleri), öğretmenler ve veliler için ayrı ayrı düzenlenmiştir.

4. ve 5. sınıf öğrencileri için aynı görüşme formları kullanılmıştır. Öğrenci görüşme formlarında 12 soru ve alt soru kullanılmıştır (bkz. Ek A, B ve C). Görüşme soruları, yaş, anne-baba eğitim düzeyi, geçen dönem fen ve teknoloji dersinde alınan not, bazı kaynakların günlük hayatta kullanımı gibi tanımlayıcı sorularla başlayıp, analitik görüşme sorularıyla devam etmiştir.

Öğretmen ve veli görüşme formları, öğrenci görüşmelerini sınıf içi ve sınıf dışı ortamlarda desteklemesi amacıyla düzenlenmiştir (bkz. Ek A, B ve C). Öğretmenlere ve velilere, temel olarak öğrencilerin çeşitli kaynakları fen öğrenimi amacıyla kullanımları ve bu kaynakların özellikleri konusundaki düşüncelerine yönelik sorular sorulmuştur.

2.4. Veri Toplama Süreci

Görüşme formları ve gözlem formu, derinlik, kapsam, farklı katılımcı gruplarına, ve araştırma sorularına uygunlukları açısından, araştırmacının danışmanı, ve aynı alanda çalışan iki meslektaşı tarafından uzman görüşü kapsamında gözden geçirilmiştir ve bu doğrultuda tekrar düzenlenmiştir. ODTÜ Uygulamalı Etik ve Araştırma Merkezi izni ve MEB onayının ardından veri toplama araçları pilot uygulamaya tabi tutulmuştur.

Pilot çalışma kapsamında, asıl görüşmeler öncesi iki 5. sınıf öğrencisi, bir 4. sınıf öğrencisi, iki veli ve bir öğretmenle Nisan 2011'de ön görüşmeler yapılmıştır. Bu sayede, sorular ve ipuçları yeniden düzenlenmiş, soruların ifade tarzları gözden geçirilmiş, soruların derinlemesine veri toplama süreci içinde kullanılabilmesi için güçlü ve zayıf yönlerine karar verilmiş ve veri toplama araçları son haline getirilmiştir. Buna ek olarak, çalışma ortamını tanımak ve resmi veri toplama sürecine yönelik fikir edinmek amacıyla görüşmelerin ilk iki saati, asıl görüşmeler öncesi pilot görüşme olarak hizmet etmiştir.

Öğrencilerle yapılan altı öğrenci katılımlı odak grup görüşmelerinin her biri 10 dakika ara ile yaklaşık iki saat sürmüştür. Odak grup görüşmelerine, dört okuldan, 4. ve 5. sınıf düzeylerinden, öğretmenlerin ve okul yönetiminin yardımlarıyla belirlenen "fen derslerine karşı ilgili olan" toplam 47 öğrenci katılmıştır. Görüşmeler, okullar tarafından gösterilen uygun yerlerde yürütülmüştür.

Çalışmanın veli örneklemini, 10 katılımcı oluşturmuştur. Velilerle yürütülen görüşmelerin her biri yaklaşık 30 dakika sürmüştür. Üç veli ile yüzyüze görüşme için uygun zaman bulunamaması nedeniyle telefon görüşmesi tercih edilmiştir.

Öğretmenler, okul günü içerisinde uygun olduklarını belirttikleri saatlerde randevu alınarak görüşülmüştür. Bu kapsamda, dört araştırma okulundan, toplamda 17 öğretmen ile görüşülmüştür. Görüşmeler, yaklaşık 30-40 dakika sürmüştür, istisnai olarak iki görüşme yaklaşık bir saat sürmüştür.

Gözlemler, dört okulda paralel olarak gerçekleştirilmiş ve toplamda 61 saat fen dersi izlenmiştir. Okul dışı ortamda öğrencilerin üç saatlik fen proje sergi etkinliği de dahil olmak üzere toplam gözlem süresi 64 saattir.

2.5. Veri Analizi

Veri analizi sürecinde, 74 katılımcıya ait görüşmeler, Eylül 2011– Aralık 2011 arasında araştırmacı tarafından yazıya dökülmüştür. Ardından tüm belgeler, okullar, sınıflar, ve farklı katılımcılar için (öğrenci, öğretmen, veli) ayrı ayrı dosyalanmıştır. Katılımcıların ve okulların isimleri kodlanmıştır. Dokümanların yazımında, kodlama ve analiz sürecinde Microsoft Ofis ve Excel programları kullanılmıştır. Araştırmacı, analizleri kağıt üzerinde kodlama ile, birinci aşama ve ikinci aşama kodlama doğrultusunda veriyi inceleme, azaltma ve yorumlama süreçlerini takip ederek (Miles & Huberman, 1994, s.12), ardından da nitel analiz programı MAXQDA 10 kullanarak yürütmüştür.

III. BULGULAR ve TARTIŞMA

Bilim iletişimi ve fen eğitimi arasındaki bağlantıdan yola çıkan bu çalışma, anlamlı ve kullanılabilir bilimsel bilgi kaynaklarını ve fen öğrenimindeki kullanımlarını araştırmaktadır. Öğrenciler, bilimsel bilgiye çeşitli kaynaklar yoluyla ulaşmaktadır. Kaynakların kullanımlarını, bu kullanım süreçlerini ve öğrencilerin bu kaynakları seçiminde etkili olan sebepleri araştırmak, derinlemesine bir analiz çalışması gerektirmektedir. Dahası, bu araştırma, kaynakların özellikleri ve öğrencilerin fen öğreniminde bu kaynakları kullanımında etkili ve etkisiz kılan yönlerini de tanımlamaktadır. Bununla paralel olarak, sonuçlara yönelik öneriler, araştırma sorularına dayalı olarak olarak üç başlık altında sunulmuştur: öğrencilerin kullanımındaki bilimsel bilgi kaynakları, bu kaynakların kullanımı ve bu kaynakları öğrencilerin fen öğreniminde etkili ve etkisiz kılan özellikler de eklenmiştir. Çalışmanın sonuçları göstermiştir ki, öğrenciler bilimsel bilgi kaynaklarını okul içi ve okul dışı öğrenme alanlarında, bilişsel (cognitive), duyuşsal (affective), kişisel bütünleştirici (personal integrative) ve sosyal bütünleştirici (social integrative) ihtiyaçları doğrultusunda dört farklı şekilde kullanmaktadır: (1) ödev/proje hazırlama amacıyla, (2) fen derslerinde, (3) sınavlara ve testlere hazırlıkta, ve (4) fene dayalı bireysel araştırmalarında. Buna ek olarak, öğrenciler, bilimsel bilgi kaynaklarının bizzat kendilerinde, sunulan bilginin içeriğinde ve sunum şeklinde birtakım özellikler aramaktadır: Anlaşılabilirlik, eğlencelilik, ilgi çekicilik, güvenilirlik, açıklık, seviyeye uygunluk, görsellik ve kolay ulaşılabilirlik. Sonuçlar, ayrıca, fen öğrenimini güçlendirmek açısından, fen eğitimi ve bilim iletişimi arasındaki bağlantıya da ışık tutmaktadır.

Öncelikle, kaynakların farklı öğrenme ortamında kullanımından bahsetmek gerekirse, ders kitapları, öğretmenler, bilimsel kitaplar (ders kitabı dışındaki), ve sınıf arkadaşları, araştırmadaki özel ve devlet okulları için genellikle "okul-temelli öğrenme ortamlarında" yararlanılan kaynaklardandır. Bu kaynakların dışında, devlet okullarında MORPA Kampüs ve Vitamin gibi eğitimsel yazılım programları da kullanımdaydı. Özel okullarda ise belgeseller ya da "Sihirli Okul Otobüsü" adlı çizgi film serisi fen derslerinde sıkça başvurulan bilimsel bilgi kaynakları olmuştur. Özel okulların aksine, devlet okullarında gözlemlenen fen derslerinde, öğrenciler, öğretmenlerden ve ders kitaplarından sıklıkla yararlanmaktadır.

"Okul dışı fen öğrenme ortamlarına" gelince, devlet okulu öğrencileri bilimsel kitapları ve interneti tercih ettiklerini söylerken, özel okul öğrencileri bu kaynaklardan ve ayrıca TV, bilimsel dergiler, bilim merkezleri ve müzelerinden ve ailelerinden de fen öğrenme amacıyla yararlandıklarını belirtmişlerdir.

Çalışmaya katılan ebeveynlerin ve öğretmenlerin büyük bir kısmı, okul ve okul dışı ortamları birbirinden ayırmaktan ziyade, her iki ortamda da çeşitli kaynakların kullanımının daha etkili bir fen öğrenimi sağlayacağını belirtmişlerdir. Benzer şekilde, araştırmanın öğrenci katılımcıları da, fen öğreniminde bu ortamları birbirinden ayırmak ve bir ortama diğerinden daha fazla değer vermek yerine, okul içi ve dışındaki ortamları bir bütün olarak değerlendirme eğilimi içerisinde olmuşlardır. Bu kapsamda okul içi ve okul dışı ortamları entegre eden bir eğitim sisteminin, öğrenci farklılıklarına daha iyi hizmet edeceği düşünülebilir. Farklı öğrenme ortamları, öğrencilerin bilgiye, zaman ve program gibi sınırlılıklar olmaksızın ulaşmalarını sağlar (Bull vd., 2008). Bu çabalar, daha etkili bir fen öğrenimi için fen eğitimi ve bilim iletişiminin ilişkilendirilmesi yaklaşımıyla benzeşmektedir. Bilimsel bilginin farklı kaynaklar yoluyla öğrenilmesi, öğrencilere farklı öğrenme deneyimleri sağlaması ve onların ihtiyaçlarına cevap vermesi açısından önem taşımaktadır. Farklı öğrenme ortamlarını ele alan Caravita'ya (1987) göre, okul içi ve dışı eğitimin birbirine entegre edilmesi kavramsal değişimi desteklemektedir. Her iki ortam da kendi karakteristik özelliklerine sahip olmasına rağmen, birlikte etkili bir öğrenmeye katkıda bulunacakları açıktır.

Veliler, öğretmenlerin, Fidan (2008), Karamustafaoğlu (2006), ve Ramey-Gassert (1997) tarafından da işaret edildiği üzere, bu iki öğrenme ortamını ilişkilendirme veya okul dışı öğrenme ortamlarını fen eğitimine dahil etme gibi konularda yeteri kadar donanımlı olmadığını belirtmişlerdir. Fakat, şu da bir gerçektir ki, öğrenme ortamının niteliği öğrencilerin fene bağlılığını arttırmada önem taşımaktadır (NFER, 2011). Stocklmayer'ın da (2001) belirttiği gibi, devlet okullarında öğrenim gören öğrencilerin bir kısmı ve öğretmenler, okuldaki fen eğitiminin çok sıkıcı olmasından yakınmaktadırlar. Buna göre, okuldaki fen eğitimi, öğrencilerin bizzat deney yapmalarından ziyade daha çok gösteri deneyleri ile dolu olması, öğrencilerin fen kavram ve ilkelerine karşı olumsuz tutum geliştirmelerine neden olmuştur.

Araştırma sonuçları, öğrencilerin bilimsel bilgi kaynaklarını kullanımlarının, okul türlerine göre değişim gösterdiğini ortaya koymuştur. Okul ortamında öğrencilerin bilimsel bilgi kaynakları öğretmenler, ders kitapları, belgeseller, çizgi filmler, farklı bilimsel kitaplar (buna test kitapları da dahil olmak üzere), bilimsel dergiler, sınıf arkadaşları, ve eğitimsel yazılım programları olmuştur. Devlet okullarında ders kitapları, öğretmenler, ve eğitimsel yazılımlar fen öğreniminde sıklıkla kullanılan kaynaklar iken, özel okullarda belgeseller, bilimsel dergiler ve okul arkadaşları öne çıkan bilimsel bilgi kaynakları olmuşlardır.

Fen öğrenimi, sadece ders kitabı odaklı eğitim-öğretim uygulamalarıyla sınırlı değildir (Weiss vd., 2003). Gözlem ve görüşmeler, devlet okullarında öğrenim gören öğrencilerin bir kısmının öğretmenler ve ders kitabı odaklı öğretim yaklaşımlarından yakındıklarını göstermiştir. Bu bulgu, Clark'ın (2000) görüşleriyle de benzeşmektedir: "Ders kitapları ve öğretmenler çoğunlukla öğrencilerin sorgulamadan sunulan bilgiyi kabul ettikleri yegâne bilgi kaynaklarıdır" (s.860). Ders kitapları, eğitimde ulaşılabilir ve ekonomik kaynaklardan biri olmasına rağmen, NCERT'de de (2006) tartışıldığı üzere yeterli bir kaynak değildir. Bununla birlikte, bulgular ders kitaplarının özel okullardaki öğrenciler için temel bilimsel bilgi kaynakları arasında bulunmadığını göstermiştir. Katılımcıların önemli bir kısmı, ders kitaplarını sınırlı bilgi içeriği ve uzun metinler nedeniyle sıkıcı bulduklarını belirtmişlerdir. Bazı veliler ve öğrenciler ders kitaplarının zaman zaman güvenilir bilgi sunmadığını belirtmişlerdir. Fen eğitiminde ulaşılabilir bir kaynak olarak nitelendirilen ders kitaplarının içerik ve içerik sunumu açısından gözden geçirilmesinin ve düzenlenmesinin öğrencileri bu kaynakların kullanımı hususunda motive edeceği ve fen öğreniminde daha etkili bir kaynak durumuna getireceği düşünülmektedir. Bu amaçla, ders kitapları, üniversitelerde görev yapan öğretim üyelerini ve TÜBİTAK gibi yayıncıları da dahil eden bir komite eşliğinde organize edilebilir.

İnternet ve bilimsel kitaplar okul dışı öğrenme ortamlarında 4. ve 5. sınıf öğrencileri tarafından sıklıkla kullanılan bilimsel bilgi kaynakları arasında yer almıştır. Bunların dışında, özel okul öğrencileri, okul dışı öğrenme ortamlarında TV, bilimsel dergiler ve bilim merkezleri/müzelerinden de fen öğrenme amaçlı olarak istifade ettiklerini belirtmişlerdir. Okul türlerine göre öğrenciler arasında görülen bu farklılaşma, bu iki grup arasındaki sosyo-ekonomik farklılıklardan kaynaklanıyor olabilir. Diğer bir deyişle, özellikle okul dışı öğrenme alanlarındaki bilimsel bilgi kaynakları arasındaki farklılık, ailelerin gelir düzeyiyle ilgili olabilir (Harvard Family Research Project, 2007). Royal Society Raporu`nda da (2008) konuya değinildiği üzere, 5-11 yaş arası öğrencilerin sosyo-ekonomik düzeyleri ve fen etkinliklerine katılımları arasında bir ilişki mevcuttur. Ayrıca, sosyo-ekonomik durum, öğrencilerin sınıfa getirdiği bilgi ve deneyimleri etkileyen faktörler arasındaydı (Duschl vd., 2007).

Yönlendiren ve yönlendirilen kaynaklar, araştırmanın beklenmeyen sonuçlarındandır. Alanyazın taramasında, yönlendiren ve yönlendirici kaynaklar arasındaki ilişkiye değinen bir araştırmaya rastlanmamıştır. Bununla birlikte, araştırmaya katılan öğrenciler, bazı kaynaklardan bir konu hakkında araştırma yaparken daha ayrıntılı bilgi edinmek istediklerinde veya konuyla ilgili soruları olduğunda başka birtakım kaynaklara başvurduklarından bahsetmişlerdir. Bu "yönlendiren" kaynaklar öğretmenler, ebeveynler, TV, bilimsel dergiler ve bilim merkezleri/müzeleri olurken, diğer bir yandan "yönlendirilen" kaynaklar öğretmenler, aileler, internet ve bilimsel kitaplar olmuştur. Sonuçlar göstermektedir ki, böyle bir yönlendirme, yönlendiren kaynakların sunduğu bilginin yetersizliğinden kaynaklanabilir. Bununla birlikte, öğretmenler ve ebeveynler hem yönlendiren hem yönlendirilen kaynaklar olarak ortaya çıkmıştır. Bu durum, öğretmenler ve aileler arasında, ileride de tartışılacak olan anlamlı bir bilimsel bilgi kaynağının sahip olduğu özellikler bakımından farklılaşma bulunmasıyla açıklanabilir. Ayrıca bu bulgu iki öneriye işaret edebilir: (1) kaynakların birbirinden ayrı olarak işlevleri olduğu düşünülmemelidir, (2) durağan olduğunu düşündüğümüz bazı kaynaklar -ders kitapları gibi- öğrencileri farklı kaynaklara yönlendirebilir; dolayısıyla yönlendirmeyi sadece insanlar yapmazlar.

Kullanımlar ve memnuniyetler kuramına göre, medya kaynakları insanların bazı ihtiyaçlarını karşılamak üzere kullanılmaktadır (Katz, Gurevitch, & Haas, 1973). Kuramın temel ilkelerinden biri de aktif katılımcılardır (Blumler & Katz, 1974). Diğer bir deyişle, kullanıcılar kaynakları kullanımlarına kendi ihtiyaçları doğrultusunda karar verirler. Kullanımlar ve memnuniyetler kuramına daha geniş bir bakış açısıyla, araştırmaya katılan öğrenciler, medya kaynakları dışındaki kaynakları da sosyal ve psikolojik gereksinimlerini tatmin etmek üzere kullanmaktadırlar. Araştırma sonuçları, Katz, Gurevitch, ve Haas (1973) tarafından belirtilen beş ihtiyaç kategorisinden dört tanesine odaklanmıştır: bilişsel, duyuşsal, kişisel ve sosyal bütünleştirici ihtiyaçlar.

Öğrenciler, ödev ve proje yükümlülüklerini yerine getirmek için ders kitaplarından, bilimsel kitaplardan, internetten, ailelerinden, ve sınıf arkadaşlarından yararlanmışlardır. Bu kullanım tarzının, Katz, Gurevitch ve Haas (1973) tarafından da tanımlanan "bilgi ve anlayış kazanmaya dair ihtiyaçlar"a yönelik (s.52) olduğu düşünülmüştür. Öğretmenler ve veliler internetin bilimsel bilgi kaynağı olarak kullanımını çoğunlukla eleştirseler de, bahsedilen bilimsel bilgi kaynakları arasında internet öne çıkmıştır. Bu bulgu, Butt vd. (2010) ve Bubela`nın vd. (2009) araştırma sonuçlarıyla uyumludur. Çalışmanın öğretmenlerin büyük bir kısmı, bilimsel bilgiye ulaşma yolunda tek bir kaynağa bağlı kalmaktansa, birden çok kaynağı işe koşmanın öğrencilerde daha kalıcı bilgi oluşturduğu kanısına varmışlardır.

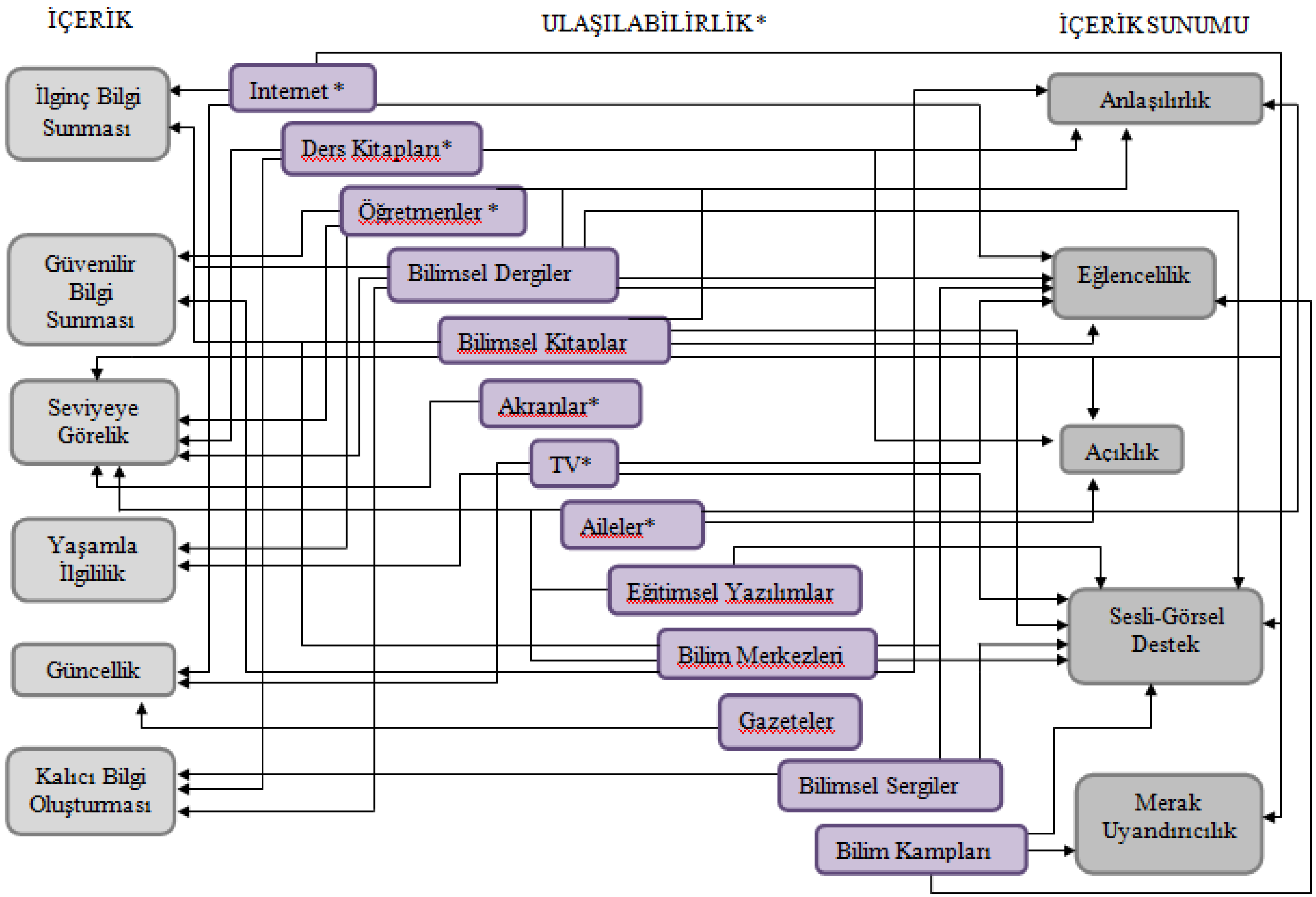
Bunun yanı sıra, ders kitapları, bilimsel kitaplar ve aileler öğrencilerin sınavlara ve SBS gibi ulusal sınavlara hazırlıkta kullandıkları kaynaklar arasındadır. Ödev ve proje yükümlülüklerini yerine getirmeye yönelik kullanımda olduğu gibi, burada da, öğrencilerin bilişsel ihtiyaçları kullanımın temel dayanağını oluşturmaktadır. Ebeveynler arasında özellikle yüksek eğitim seviyesinde olan velilerin, öğrencilerin okula yönelik sınavlara ve testlere hazırlıklarında başvurdukları kaynaklar arasında olduğu ortaya çıkmıştır. Ders kitapları, genellikle okula yönelik sınavlara hazırlıklarda kullanılırken, bilimsel kitaplar, bunlara test kitapları da dahil olmak üzere, SBS gibi sınavlara hazırlıkta kullanılan kaynaklar arasındadır.

Bilimsel bilgi kaynaklarının bir diğer kullanımı da öğrencilerin bireysel fen araştırmalarına yönelik kullanımları olarak ortaya çıkmıştır. Burada, şunu da belirtmek gerekir ki, öğrenciler ders yükümlülüğü olmadığı takdirde bilimsel araştırma yapmamayı tercih etmektedirler. Bununla birlikte, araştırma yaptıklarında ise ulaşılabilir ve zengin bilgi içeriği sunmaları yönüyle internet, bilimsel kitaplar, bilimsel dergiler, ders kitapları, ve aileleri gibi kaynaklardan yararlandıklarını belirtmişlerdir. Bu kullanımın ardında Katz, Gurevitch, ve Haas (1973) tarafından da açıklandığı üzere bilişsel, kişisel ve sosyal bütünleştirici ihtiyaçlar bulunmaktadır. Buna göre, bireysel araştırmalar yoluyla öğrenciler konuya yönelik sadece bilgi ve anlayış kazanmanın yanı sıra (bilişsel ihtiyaçlar), aynı zamanda ilgi alanlarına yönelik konularda araştırma yaparak (duyuşsal ihtiyaçlar), ve arkadaşlar ve öğretmenler ile iletişim ve paylaşım içinde olmaları yönüyle de (sosyal bütünleştirici ihtiyaçlar) farklı ihtiyaçlarına hitap etmektedir.

TV, internet, gazeteler ve dergiler öğrencilerin bilimsel araştırma sonuçlarının paylaşımında tercih ettiği kaynaklardandır. Öğrencilerin araştırma bulgularını diğer insanlarla paylaşıma istekli olmaları Katz vd. (1973) tarafından da belirtildiği üzere öğrencilerin kişisel (prestij ve konum kazanma) ve sosyal bütünleştirici (insanlarla iletişimde olma) ihtiyaçlarına yöneliktir.

Kaynakların kullanımında veliler ve öğrenciler arasında gözlenen kuşak farklılıkları çalışmanın beklenmedik sonuçlarından biridir. Bu durum, velilerin ev ödevlerinde çocuklarına yardım etmekten çok, neredeyse büyük bir kısmını kendilerinin yapmasıyla ilgili şikayetleri ile birleştiğinde, kaynakların niçin ve nasıl kullanılacağına yönelik bir gerilim durumu ortaya çıkmaktadır. Ev ödevlerinin daha açık ve etkili olabilmesinin bir yolu, öğretmenlerin hangi kaynakların ne zaman ve niçin kullanıma uygun olduğunu açıklığa kavuşturması yoluyla çözümlenebilir.

Özetle, sonuçlar göstermektedir ki, öğrencilerin bilimsel bilgi kaynaklarını kullanımlarını etkileyen temel faktörler Şekil 2`de de gösterildiği gibi, kaynakların ulaşılabilirliği, içerik, ve sunumunun kalitesi gibi eksenler etrafında dönmektedir. Buna göre, ulaşılabilir kaynaklar (TV, aile, internet, ders kitapları), ilginç bilgi içeriğine sahip (TV, internet, bilimsel dergiler, bilim müzeleri/merkezleri), güvenilir (öğretmenler, veliler, ders kitapları, bilimsel kitaplar, bilimsel dergiler, bilim merkezleri/müzeleri) ve güncel bilgi sunan kaynaklar (TV, internet, gazeteler) öğrencilerin bilimsel bilgiye erişimlerinde tercih ettikleri kaynaklar olarak öne çıkmaktadır. Dahası, kalıcı bilgi sunmak da (TV, bilimsel dergiler, öğretmenler, veliler) kaynakların tercih edilmesinde bir kaynağı etkili kılan faktörler arasındadır.



Şekil 2. Bilimsel bilgi kaynaklarını etkili kılan özellikler.
Not (*) Ulaşılabilir kaynaklar. Okların yönleri, ögeler arasındaki ilişkiyi göstermektedir. Orta kısımdaki bilimsel bilgi kaynakları rastgele sıralanmıştır.

İçerik sunumuyla ilgili olarak, anlaşılabilirlik (ders kitapları, bilimsel kitaplar, öğretmenler, aileler, bilim merkezleri/müzeleri), eğlencelilik (bilimsel dergiler, bilimsel kitaplar, internet, bazen öğretmenler ve aileler), açıklık (TV, bilimsel dergiler, bilimsel kitaplar), görsellik (TV, bilimsel kitaplar, bilimsel dergiler, eğitimsel yazılım programları), merak uyandırıcılık (TV, internet, bilimsel dergiler, bilimsel kitaplar) öğrencilerin bilimsel bilgi kaynaklarını kullanımlarında önem taşımaktadır.

Medya kaynakları, genellikle "geniş bir kitleye hitap eden", "ulaşılabilir" kaynaklar olarak nitelendirilmiştir. Medya kaynakları arasında, internet, kullanım kolaylığı ve ulaşılabilir olması yönüyle öne çıkmaktadır. Bu sonuç, alanda yapılan diğer çalışmalarla da uyumludur (Butler, 1995; Clark, 2000; Falk & Dierking, 2010; Horrigan, 2006; NFER, 2011). Clark (2000), çalışmasında bu bulguyu şöyle desteklemektedir: "Bu yeni kaynak geleneksel öğretimde kullanılanların ötesinde bilimsel tartışma becerilerinin gelişimini de desteklemektedir" (s.859).

Kaynağın güvenilirliği öğrenciler tarafından vurgulanan diğer bir husustur. Görüşme sonuçları, öğretmenlerin, bilimsel kitapların, bilim merkezleri/müzelerinin ve gazetelerin öğrencilere güvenilir bilgi sunan bilimsel kaynaklar olduğuna işaret etmektedir. Horrigan`ın (2006), katılımcıların interneti bilimsel bilgiye ulaşımda güvenilir bir kaynak olarak nitelendirdiği çalışmasının aksine, katılımcılar interneti sunduğu bilginin güvenilirliği ve gerçekliği açısından eleştirmektedir. Öğrenciler genellikle internet aracılığıyla eriştikleri bilimsel bilgiyi farklı sitelerden karşılaştırmak suretiyle ya da aileleri, öğretmenleri ve bilimsel kitaplar aracılığıyla kontrol etmektedir. Bu sonuç, Horrigan`ın (2006) "İnternet aracılığıyla bilimsel haberlere ve bilgilere erişen bireylerin %80`i en azından bir "hızlı-kontrol" aktivitesiyle bu bilgilerin doğruluğunu test etmektedir" (s.2).

Çalışmaya katılan öğrencilere göre, fen öğrenimi çeşitli örneklerle ve gerşek yaşam tecrübeleriyle desteklendiğinde kendilerinde daha anlamlı ve daha kalıcı bilgi oluşturmaktadır. Burada, okul içi ve okul dışı öğrenme ortamlarını bağlantılamaya yönelik bulgular, Cajas`ın (1999) okul fen öğrenimini gündelik yaşama entegre etmeyi kolay ve genellikle beklenen bir eğitimsel hedef olarak gördüğü çalışmasıyla uyumludur. “Öğrenme aynı zamanda her yerde süregelen bir aktivite olmasına rağmen çoğunlukla böyle algılanmamaktadır” (Lave, 1993, s.5). Yerleşmiş öğrenmeler kuramı, gerçeklerin ezberlenmesinden çok, bilginin öğrenildiği alan ve uygulamalara değer vermektedir (Heeter, 2005). Diğer bir yandan, TV`nin öğrencilerce ifade edilen kalıcı ve hatırlanabilir bilimsel bilgiler sunduğu kısmı Gregory ve Miller`ın (2000) çalışmasıyla uyuşmamaktadır.

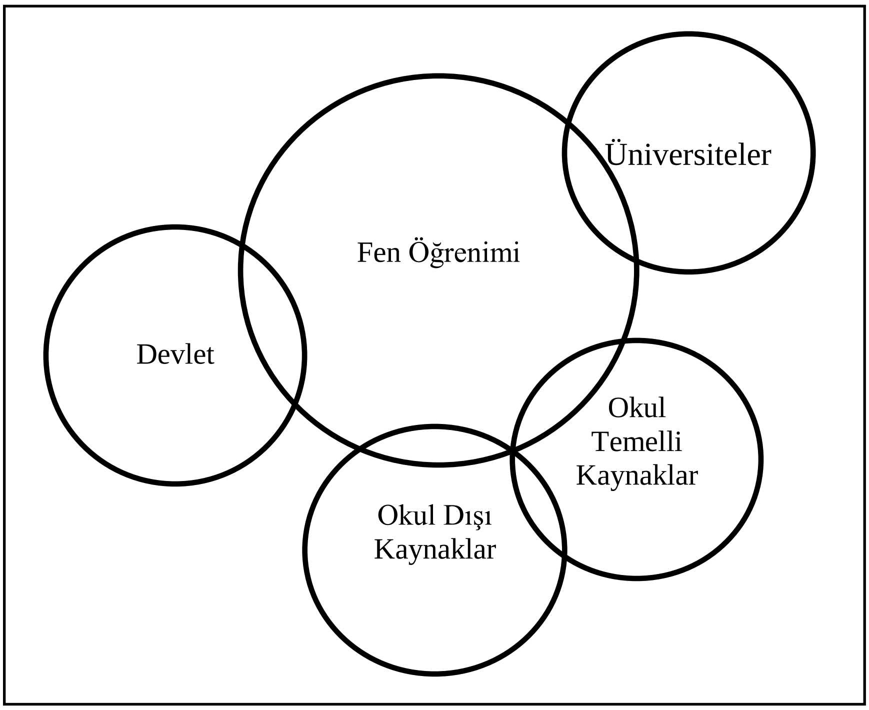
Araştırmanın bir diğer önemli bulgusu ise, içerik sunumunda eğlenceli ögelerin aranması olarak ortaya çıkmıştır. Buna göre, TV, internet, bilimsel dergiler, bilimsel kitaplar ve bilim merkezleri/müzeleri fen konularına eğlence katan unsurlara sahiptir. Bu bulgu, Gilbert`ın (2008) fikirlerine paralel bir görüş ortaya koymaktadır: "Toplumun fen ve teknoloji konularına karşı ilgisiz olmasının nedenini, ‘eğlenceli’ olmamasına dayandıran bir argüman bulunmaktadır, aksi durumda toplum bilimle daha sıkı bir bağ kurmak için istekli olacaktır” (s.123).

Anne, babayı, kardeşleri, teyze, kuzen gibi yakın aile üyelerini de içine alan aile, öğrencilerin fen öğreniminde kullandıkları bir diğer bilimsel bilgi kaynağı olarak ortaya çıkmıştır. Dünya Bankası Raporu`na göre (2011), aile bireyleri öğrencilerin fen eğitimine bağlılıklarında “önemli kişiler”di. (s.29). Benzer şekilde, Miller (1987) bunu biraz daha detaylandırarak şöyle söyler “…öğrencilerin fen ve matematik konularına karşı olumlu tutum geliştirmesinden en etkili kaynak ailedir” (s.177). Fen eğitimine dair alanyazında da, velilerin tutumunun çocukların fen öğrenimine önemli ölçüde katkıda olduğuna dair veriler bulunmaktadır (Dierking & Falk, 2003; Rounds, 2004). Alanyazınla paralel şekilde, bu çalışma, özellikle eğitimli velilerin, öğrencilere fen öğreniminde destek olduğunu ortaya koymaktadır. Çalışmaya katılan bazı öğretmenler her ne kadar velilerin bazı durumlarda öğrencilerde kavram kargaşalarına yol açtıklarını iddia etseler de, velilerin öğrencilerin fen öğrenimine olan katkısı önemlidir. Bu nedenle, öğretmenler, çocukların evde velileriyle birlikte ve onların desteğiyle yapacakları şekilde fen aktiviteleri oluşturduklarını da belirtmişlerdir.

IV. ÖNERİLER

4.1. Uygulamalara Yönelik Öneriler

Araştırma sonuçları, uygulamalar ve ileriye yönelik araştırmalar için bir kısım öneriler sunmaktadır. Görüşme, gözlem ve doküman analizi yoluyla edinilen verilere göre, okul içi ve okul dışı ortamlar, eğitime yönelik hükümet politikaları ve üniversiteler, öğrencilerin fen öğrenimine doğrudan ya da dolaylı yollarla etkileri olan ortamlardır (bkz. Şekil 3). Bu doğrultuda, ilerleyen bölümde araştırma sonuçlarının uygulamaya yönelik yansımalarına değinilecektir.



Şekil 3. Fen öğrenimi altyapısı.

Bilimsel Bilgi Kaynaklarına Yönelik Öneriler: Yapılan analizler göstermektedir ki, velilerin ve öğretmenlerin bilimsel bilgi kaynağı olması yanında, yönlendirici bir konumda olması da aynı ölçüde önem taşımaktadır. Buna göre, öğretmenler ve veliler, öğrencileri farklı kaynaklara yönlendirirken, aynı zamanda bu kaynakların fen öğretiminde kullanılması konusunda öğrencileri teşvik edebilir, hangi kaynakların, nasıl, ne zaman, ve ne kadar kullanılacağı ile ilgili öğrencilere rehberlik edebilir. Bunun yanısıra öğretmenler, ödev ve projeler yoluyla, öğrencilerin farklı kaynaklar vasıtasıyla bilimsel bilgiye ulaşmasını sağlayabilir.

Yapılan analizlere göre, öğrencilerin medya kaynaklarından TV yoluyla bilimsel bilgiye erişimde zorlandıkları ortaya çıkmıştır. Öğrenciler, kendi düzeylerindeki programların genellikle okul saatlerinde yayında olduğundan ve bu nedenle birçoğunu izleyemediklerinden yakındılar. Bununla birlikte, öğretmen ve velilerin bir kısmı da, TV`de öğrencilerin ilgisini dağıtacak ölçüde reklam ve tanıtım olmasından şikayet etmekteydiler. Bu noktada, özellikle çocuklara yönelik bilimsel programlarının, haftasonlarında, akşam saatlerinde ve eğer mümkünse reklamlara sınırlı oranda yer verilerek yayınlanması önerilebilir. Öğrencilerin doğru programlara yönlendirilmesi ve kaliteli programlara erişmesi doğrultusunda yine öğretmenlere ve velilere önemli görev düşmektedir.

Gazeteler, metinlerinin uzunluğu, görselliğinin azlığı, seviye üstü bulunması, ya da bilimsel bilgi içeriğinin azlığı gibi nedenlerle, bilimsel bilgiye erişim konusunda öğrenciler için geri planda kalmaktadır. Bu bağlamda, gazetelerde ayrı bir renkli, resimli "çocuk sayfası" ilave edilerek burada bilimsel haberler sunulabilir, ya da haftasonu "çocuk gazetesi" gibi bir ek yoluyla bu yaş düzeyindeki çocukların gazeteye ve bilimsel bilgiye gazeteden erişme doğrultusundaki ilgileri çekilebilir. Böyle bir gayret, özellikle okumaya karşı ilginin düşüş gösterdiği de gözönüne alınacak olursa (Birkök, 2008), anlamlı olacaktır.

Araştırma sonuçları göstermektedir ki, öğrenciler ders kitaplarını okulda fen öğreniminde ya da fen ile ilgili araştırmalarında yetersiz bulmuşlardır. Bu, açıkçası, ders kitaplarına öncelikli bir rol yüklemekten ziyade, öğrencilerin hızla değişen bilimsel ve teknolojik dünyaya adapte olabilmeleri açısından kaynakların düzenli olarak gözden geçirilmesi önerisidir. Gilbert'a göre (2008) fen eğitimi bilimdeki ilerlemeleri takip etme ve uyum sağlama açısından geride kalmaktadır, ya da bunu oldukça yavaş yapmaktadır. Ders kitaplarını her yıl değiştirmek ve yeniden basmak finansal koşulları gözönüne alarak çok makul bir çözüm gibi görünmese de, daha güncel kaynaklar öğrenme-öğretme sürecine entegre edilebilir. Bu kapsamda, devlet okullarında yeni bir proje olarak uygulamaya geçecek olan "FATİH Projesi" bir iyileştirme yolu olabilir. Proje, bakanlık tarafından Türkiye genelinde öğrencilere tablet bilgisayarlar dağıtılması ve sınıflara akıllı tahtalar ulaştırılması suretiyle sınıfları akıllı sınıflara dönüştürme fikrinden yola çıkmıştır (MoNE, 2012). Bu durumda, ders kitaplarının tablet bilgisayarlarla yer değiştirmesi söz konusudur. Dolayısıyla, bundan sonraki çalışmalarda bu tablet bilgiyarların fen öğreniminde kullanımı yanında etkililiği de araştırılabilir.

Bilim İletişimcileri Olarak Öğrenciler: Sonuçlar ortaya koymaktadır ki özellikle devlet okulu öğrencileri, araştırma yapmak ve bunun sonuçlarını akranlarıyla ya da öğretmenleriyle paylaşma konusunda sınırlı imkanlara sahipti. Öğrenciler, okullarda, farklı kaynakları işe koşarak araştırma yapma ve bunun sonuçlarını öğretmenleri, arkadaşları ve daha geniş bir çerçevede diğer insanlarla paylaşmaları hususunda teşvik edilmelidir ki, böyle bir faaliyet, eğitim ve iletişim kabiliyetlerinin gelişmesini gerektirir.

Öğrenen Olarak Öğrenciler ve Öğretmenler: Çalışmaya katılan öğrenciler, bilimsel ve teknolojik gelişmeler hakkında bilgi edinmek istediklerini belirtmişlerdir. Bunun için, çalışma boyunca bahsedilen bilimsel bilgi kaynaklarına alternatif olarak, "Cafe Scientifique" olarak bilinen etkinlikler de düzenlenebilir. Böyle bir etkinlikte, öğrenciler bilim insanları ile birlikte informal kafe ortamında bir yandan kahvelerini içerken, diğer bir yandan güncel bilimsel ve teknolojik konular hakkında fikir paylaşabilirler. Genellikle yetişkinler için düzenlenen "Cafe Scientifique" etkinliğinin çocuklara yönelik versiyonu olan "Junior Cafes" ilk olarak Fransa'nın Lyon şehrinde, 1999 yılında yapılmıştır ve ardından Amerika'da, Japonya'da ve Almanya'da genellikle 15-18 yaşlar arasındaki genç katılımcılar için, Cafe Scientifique etkinliğine paralel şekilde devam etmiştir (Grand, 2009). Bu aktivite, Türkiye'de de 4. sınıf düzeyinden itibaren öğrencileri ve eğitimcileri kapsayacak şekilde düzenlenebilir.

Farklı Türde Kaynakları Birleştirmek: Katılımcılar, öğrencilere daha anlamlı bir fen öğrenimi sağlaması açısından farklı öğrenme ortamlarının ve farklı türde kaynakların birleştirilmesinden yanaydı. Bu doğrultuda, bilimsel ve teknolojik gelişmeleri takip edebilmek ve yeniliklere ayak uydurabilmek için gazeteler, TV, internet ve dergiler fen programlarına entegre edilebilir. Okul içi ya da okul dışı ortamlarda kullanılmasına bakılmaksızın, TV ve internet, çocukların ve yetişkinlerin yaşamlarında önemli bir yere sahiptir. Medya kaynaklarını bilimsel bilgi kaynakları olarak ele alıp değerlendirmek yeni bir konu olmasına rağmen düşünülebilir ve uygulanabilir bir yanı bulunmaktadır. Hemen hemen her hanede TV, son zamanlarda da internet, ve dolayısıyla bilgisayarlar da bir çeşit demirbaş olarak bulunmaktadır. Medya kaynakları genellikle bilim iletişimine atfedilse de, eğer yaşamlarımızda vazgeçilmez bir öneme sahipse, bu durumda fen eğitimi alanında da öğrenimi destekleyici araçlar olarak kullanımları için yeni yaklaşımlar bulunabilir. Bu doğrultuda, TV ve internetin ulaşılabilir yönü genç bireylere ulaşması ve fene karşı ilgilerinin arttırılmasında bir yol olarak düşünülebilir (NFER, 2011). Benzer şekilde, güncel araştırmalar göstermiştir ki bu kaynaklar birlikte işlev gösterirlerse, bilimsel bilgiyi öğrencilere ulaştırma hususunda daha başarılı olunabilir.

Fen Ünitelerinin Azaltılması: Çalışmanın öğretmen katılımcıları, sınıfta farklı bilimsel bilgi kaynaklarını kullanmak ve sınıfta öğrencilerin keyif alabileceği eğlenceli aktiviteler yapmayı istediklerini fakat belirli bir zamanda işlenmesi gereken ünitelerin yoğunluğu ve kısıtlı ders saatlerinden ötürü buna fırsat bulamadıklarından yakınmışlardır. Bu nedenle, çalışmanın sonuçları göstermiştir ki, programın fen derslerini zenginleştirecek aktivitelerle ve öğrenme öğretme süreçleriyle yeniden organize edilmesi daha etkili bir fen öğrenimine katkıda bulunabilir.

Hizmet-içi Eğitim: Özellikle devlet okullarındaki bazı öğretmenler, kendilerini deney ve aktivitelerin yapılması hususunda yetersiz hissetmektedir. Buna bir çözüm olarak, öğretmenler, bilimsel bilgi kaynağı olarak, bilim insanlarınca düzenlenen hizmet içi eğitim seminerlerine düzenli olarak katılarak, bilgilerini güncelleme ve fen ve teknoloji alanlarındaki ilerlemelerden haberdar olma fırsatı bulabilirler. Bu eğitimler, öğrencilerin nasıl öğreneceği ve fenin nasıl öğretileceği temellerine dayanmasının yanı sıra (Duschl vd., 2007) kaynakların fen öğretiminde kullanımı konusuna da yönelebilir (Hakverdi & Dana, 2012).

Öğretmen Yetiştirme Programlarını Düzenlemek: İlköğretim Fen Bölümünde, öğretmen eğitimi programlarının bilimin sosyal doğası ve medya kaynaklarıyla iletilmesi hususlarında zenginleştirilmesi, araştırma öneri arasında yer alabilir. Fen eğitimi ve bilim iletişimine dair ögelerin birbirlerine entegre edilerek hizmet öncesi öğretmen programlarına dahil edilmesi Ramey-Gassert (1997) tarafından da ifade edildiği üzere programı zenginleştirerek öğretmen yetiştirme programlarına katkısı olabileceği düşünülmektedir: "Öğretmenlerin eğitimde üstlendiği önemli rolü anlamak, öğretmen eğitimi programları ve hizmet içi mesleki eğitim programlarından başlayan değişim sürecininin asıl parçasıdır." (s.444)

5.3. Diğer Araştırmacılar için Öneriler

Bu bölümde, çalışmanın sonuçlarına dayalı olarak, fen eğitimi ve bilim iletişimi alanlarında yapılacak araştırmalara yönelik öneriler sunulmuştur.

Bilim İletişimi Alanında Çalışmalar: "Bilim İletişimi" özellikle Türkiye'de araştırma yapmaya çok açık ancak mevcut durumda hakkında oldukça az araştırma olan bir alandır. Bu çalışma, fen eğitimi ve bilim iletişimi alanlarındaki araştırmacıların, iki disiplin arasındaki bağıntıdan yola çıkarak, gayretlerini birleştirecekleri alanları vurgulamaktadır. Bu doğrultuda, yetişkinlerin ya da genç bireylerin bilim algıları ya da farklı bilim iletişimi araçlarını kullanımlarına yönelik nitel ve nicel araştırmaların, literatüre önemli ölçüde katkıda bulunacağı düşünülmektedir.

Öğrencileri Okul Dışı Ortamlarda Gözlemlemek: Bu araştırmada, öğrenciler sadece sınıf içi fen öğrenme ortamlarında gözlemlenmişlerdir. Öğrencilerin farklı öğrenme ortamlarında nasıl ve ne şekilde bilimsel bilgi edindiklerini incelemek için, okul dışı öğrenme ortamlarında da gözlemler yapılabilir.

Veri Toplama Aracı Olarak Sesli Düşünme Yöntemi: Araştırmanın temel veri toplama aracı görüşmelerdi. Özel olarak, araştırmada öğrencilerin fen öğrenimine ilişkin derinlemesine very toplamak amacıyla odak grup görüşmelerinden yararlanılmıştı. Buna alternatif olarak, öğrenciler, bilimsel bilgi kaynaklarının etkili ve etkisiz özellikleri ile bu kaynakları kullanımları hakkında sesli düşünme yöntemiyle de görüşülebilir.

Karma Dizayn Çalışmaları: Fen eğitimi ve bilim iletişiminin birbirini tamamlayıcı doğası gözönüne alınarak, bu çalışma medya kaynakları da dahil olmak üzere öğrencilerin bilimsel bilgi kaynaklarını kullanımları ve bu kaynakların ve kullanımların etkili ve etkisiz yönlerini araştırmaktadır. Görüşme protokolleri öğrencilerle, öğretmenlerle ve velilerle yürütülen ön görüşmelere ve alanyazına dayalı olarak geliştirilmiştir. Bu nedenle, veri toplama araçlarının geliştirilmesinde sınırlı bir gruptan edinilen veri, veri toplama araçlarına yansıltılmıştı. Bunun yanında, bu çalışma daha geniş ölçekli veri toplama araçlarının geliştirilmesinde bir temel olarak kabul edilebilir. İleride yapılacak çalışmalar için, görüşme formları pilot görüşmeler ve araştırma sonuçları ışığında yeniden düzenlenebilir ve bilimsel bilgi kaynaklarının öğrencilerin fen öğrenmeleri üzerine etkilerini araştırmak amacıyla geliştirilebilir. Medya kaynaklarından veri toplama ve yorumlama hususundaki zorluklara rağmen (Gregory & Miller, 2000), nitel ve nicel araştırma yöntemlerine dayalı süremli araştırmalarla bilimsel bilgi kaynaklarının etkisi olup olmadığı incelenebilir.

Süremli Araştırmalar: Çocukluk döneminde fene dayalı tecrübelerin ileride yetişkinlik döneminde bilimsel aktivitelere katılımı, nitel ve nicel metodlar işe koşularak incelenebilir. Böyle bir araştırma, fen eğitimi ve bilim iletişimi alanyazınına çocukluk dönemi ve yetişkinlik dönemi arasındaki olası ilişkiyi de vurgulaması açısından katkıda bulunabilir.

APPENDIX O
CURRICULUM VITAE

I was born in Bursa, Türkiye, on September 1, 1984. I am both a scientist and social scientist with training in science and technology and educational sciences. I studied science education and received my B.A. degree in 2006. I have been working as a research assistant in the Department of Educational Sciences at Middle East Technical University since 2007. For the next four years, I conducted research on science communication participating various workshops, seminars, and organizations including presentations for Queen Elizabeth, Prince Philip-Duke of Edinburgh and David Lammy-Minister of Education. I studied in University of Cambridge and University of Cardiff in Britain. I was a FameLab finalist as a science communicator in 2008 and 2009. The competition was published in NTV (a well-known TV channel in Türkiye). Between 2011-2012, I was a visiting scholar at University of Wisconsin-Madison. During my stay in the U.S., I enhanced my field knowledge on my research interests: science communication, science education, curriculum, teacher education, and qualitative studies.

APPENDIX P

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü	
Sosyal Bilimler Enstitüsü	X
Uygulamalı Matematik Enstitüsü	
Enformatik Enstitüsü	
Deniz Bilimleri Enstitüsü	

YAZARIN

Soyadı: Gelmez - Burakgazi
Adı : Sevinç
Bölümü: Eğitim Bilimleri

TEZİN ADI: Connecting Science Communication to Science Education: A Phenomenological Inquiry into Multimodal Science Information Sources Among the 4th and 5th Graders

TEZİN TÜRÜ: Yüksek Lisans [ ] Doktora [X]

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. [ ]

2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) [ ]

3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) [X]

Yazarın imzası Tarih
28.12.2012