

A CASE STUDY ON THE APPLICABILITY OF INTERDISCIPLINARY
APPROACHES IN HIGH SCHOOL SCIENCE AND MATHEMATICS LESSONS
FROM PERSPECTIVE OF TEACHERS

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APPROACHES IN HIGH SCHOOL SCIENCE AND MATHEMATICS
LESSONS FROM PERSPECTIVES OF TEACHERS**

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ABSTRACT

A CASE STUDY ON THE APPLICABILITY OF INTERDISCIPLINARY APPROACHES IN HIGH SCHOOL SCIENCE AND MATHEMATICS LESSONS FROM PERSPECTIVE OF TEACHERS

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This research aims to discuss the feasibility of integrating interdisciplinary studies into education in the fields of science and mathematics at the high school level and possible barriers to the integration of these studies into the education system.

In order to collect data, document analysis and informal observation were made, semi-structured interviews were designed. Interview questions consist of two parts. In the first part, demographic information; in the second part, the feasibility of interdisciplinary studies in high school science and mathematics, obstacles that may occur before or during implementation, teacher and student readiness, and the benefits of interdisciplinary education were asked. 13 teachers working in a private high school participated in the interview.

The findings of the study show that interdisciplinary studies performed between the fields of science and mathematics at high school level. According to teachers' opinions, in order to increase the applicability of interdisciplinary studies, interdisciplinary connections between education programs should be high, the level of readiness of the teacher and the student should be high, the content of the work to be done should be planned in detail and the school culture should be suitable for interdisciplinary studies.

In addition, the reasons for the obstacles in front of the feasibility of interdisciplinary studies in the opinions of the teachers are the lack of communication between the teachers of different disciplines, the lack of motivation in both the student and the teacher due to the fact that a test-centered education is essential, and the lack of time.

Keywords: Interdisciplinary education, interdisciplinary approach, science education, mathematics education

ÖZ

ÖĞRETMEN BAKIŞ AÇISI İLE LİSE FEN VE MATEMATİK DERSLERİNDE DİSİPLİNLERARASI YAKLAŞIMLARIN UYGULANABİLİRLİĞİ ÜZERİNE BİR VAKA ÇALIŞMASI

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Bu araştırma, disiplinlerarası çalışmaların lise düzeyinde fen ve matematik alanlarında eğitime entegre edilmesinin uygulanabilirliğini ve bu çalışmaların eğitim sistemine entegrasyonun önündeki olası engelleri tartışmayı amaçlamaktadır.

Araştırmada veri toplamak amacı ile döküman analizi, yapılandırılmamış gözlem yapılmış ve yarı yapılandırılmış görüşme dizayn edilmiştir. Görüşme soruları iki bölümden oluşmaktadır. Birinci bölümde demografik bilgiler; ikinci bölümde ise disiplinlerarası çalışmaların lise fen ve matematik alanlarında uygulanabilirliği, uygulanma öncesi veya uygulanma esnasında oluşabilecek engeller, öğretmen ve öğrenci hazırbulunuşlukları ile disiplinlerarası eğitimin yararları sorulmuştur. Görüşmeye özel bir lisede çalışan 13 öğretmen katılmıştır.

Araştırmanın bulguları lise düzeyinde fen ve matematik alanları arasında disiplinlerarası çalışmaların yapılmadığını göstermektedir. Öğretmen görüşlerine göre disiplinlerarası çalışmaların uygulanabilirliğinin artması için eğitim programları arasında disiplinlerarası bağlantıların fazla olması, öğretmen ve öğrencinin hazırbulunuşluk seviyesinin yüksek olması, yapılacak çalışmanın içeriğinin detaylı

planlanması ve okul kültürünün disiplinlerarası çalışmaların yapılmasına uygun olması gerekmektedir. Ayrıca öğretmen görüşlerinde disiplinlerarası çalışmaların yapılabilirliğinin önündeki engeller için ise farklı disiplin öğretmenleri arası iletişimin kopuk oluşu, test merkezli bir eğitim-öğretimin esas oluşu sebebiyle hem öğrenci hem de öğretmende motivasyon olmayışı ve zaman eksikliği sebep gösterilmiştir.

Anahtar Kelimeler: Disiplinlerarası eğitim, disiplinlerarası yaklaşım, fen eğitimi, matematik eğitimi

Dedicated to my family

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TABLE OF CONTENTS

PLAGIARISM	iii
ABSTRACT	iv
ÖZ.....	vi
DEDICATION	viii
ACKNOWLEDGMENTS.....	ix
TABLE OF CONTENTS	x
LIST OF TABLES	xiv
LIST OF FIGURES.....	xv
LIST OF ABBREVIATIONS	xvi
CHAPTERS	
1. INTRODUCTION.....	1
1.1. Background of the Study.....	1
1.2. Statement of Problem	3
1.3. Purpose of the Study	4
1.4. Significance of the Study	4
1.5. Definition of Terms.....	6
2. LITERATURE REVIEW.....	7
2.1. Motives of Merging Disciplinarity in Education.....	7
2.2. Definition of Interdisciplinary Methodology in Education.....	10
2.3. Historical Evaluation and Theory of Interdisciplinary Methodology in Education.....	12
2.4. Designing and Implementation an Interdisciplinary Study in Curriculum	13
2.5. Importance of Interdisciplinary in Education.....	17

2.6. Current Problems of Application of Interdisciplinary Studies in Turkey	18
2.7. The Problem of Preparing a Curriculum with Interdisciplinary Perspective.	20
2.8. Constraints of Interdisciplinary of Education	23
2.9. Studies on Interdisciplinary Approach.....	24
2.9.1. Related studies in Abroad	24
2.9.2. Related studies in Turkey.....	26
2.10. Summary of Literature Review	31
3. METHOD.....	33
3.1. Overall Design of the Study.....	33
3.2. Research Questions	36
3.3. Data Sources.....	37
3.3.1. Participants.....	38
3.3.2. The case.....	40
3.3.3. Documents	42
3.4. Data Collection Instruments and Procedures	42
3.4.1. Semi-structured interviews.....	43
3.4.2. Informal observations.....	45
3.4.3. Document analysis	45
3.5. Data Analysis	46
3.5.1. Transcribing the data.....	46
3.5.2. Coding the data	47
3.5.3. Presentation of the results	49
3.6. Trustworthiness	49
3.6.1. Internal validity and external validity	49
3.6.2. Internal reliability and external reliability.....	51
3.7. Ethical Issues.....	51
3.8. Limitations	52

3.9. Role of the Teacher	52
4. FINDINGS	54
4.1. Applicability of Interdisciplinary Studies	54
4.2. Requirements of Interdisciplinary Studies	56
4.2.1. School culture.....	57
4.2.2. Content	59
4.2.3. Study environment	60
4.2.4. Teacher and student readiness.....	61
4.2.5. Roles.....	62
4.2.6. Assessment.....	63
4.3. Benefits of Interdisciplinary Studies (Aims to Develop)	63
4.3.1. Benefits of interdisciplinary studies for students	64
4.3.2. Benefits of interdisciplinary studies for teachers	66
4.4. Restrictions.....	67
4.4.1. MoNE curriculum	68
4.4.2. Time and workload of teacher.....	71
4.4.3. Student and teacher readiness	72
4.4.4. Motivation and continuity	73
4.4.5. Prejudice and misconceptions	74
4.4.6. Group dynamics	75
4.5. Education of Teacher	76
5. DISCUSSION AND IMPLICATIONS	79
5.1. Discussion of the Results	79
5.1.1. Applicability of interdisciplinary studies	79
5.1.2. Benefits of interdisciplinary studies.....	90
5.2. Implications for Practice	91
5.3. Implications for Further Research.....	92

REFERENCES.....	94
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APPENDICES

A. INFORMED CONSENT FORM	112
B. TEACHER INTERVIEW	114
C. CODING LIST	118
D. AN EXAMPLE OF CODED/ LABELLED INTERVIEW SCRIPT	121
E. METU HUMAN SUBJECTS ETHICS COMMITTEE	121
F. TURKISH SUMMARY/TÜRKÇE ÖZET	123
G. THESIS PERMISSION FORM	131

LIST OF TABLES

Table 3.1 Information Sources Used in Case Study Research.....	37
Table 3.2 The Date and Length of the Pilot Studies.	44
Table 3.3 The Date and Length of the Interviews.....	44
Table 3.4 Classification of Quotes	47

LIST OF FIGURES

Figure 2.1 The Difference Between the Disciplinarity.....	11
Figure 2.2 Example of an Interdisciplinary Concept Model.....	15
Figure 3.1 The General Flowchart of the Research Design.....	36
Figure 3.2 The General Data Analyses Steps.....	48
Figure 3.3 Triangulation of the Data.....	50
Figure 4.1 Requirements of Interdisciplinary Studies.....	57
Figure.4.2 Benefits of Interdisciplinary Studies for Students.....	66
Figure 4.3 Benefits of Interdisciplinary Studies for Teachers.	67
Figure 4.4 Restrictions.	68
Figure 5.1 Applicability of Interdisciplinary Education in MASELSA School.	81

LIST OF ABBREVIATIONS

IB DP	: International Baccalaureate Diploma Programme
ICGSE	: International General Certificate of Secondary Education
MoNE	: Ministry of National Education
OECD	: Organisation for Economic Co-operation and Development
PISA	: Programme for International Student Assessment
STEM	: Science, Technology, Engineering and Mathematics
TALIS	: Teaching and Learning International Survey
TUBITAK	: The Scientific and Technological Research Council of Turkey
URL	: Uniform Resource Locator

CHAPTER 1

INTRODUCTION

In the first chapter; background of the study, the statement of the problem, the purpose of the study, the research questions, the significance of the study are introduced.

1.1. Background of the Study

It is accepted in many countries that there is a gap between school and real life, even though the demands of interdisciplinary aspects of education have required the model to shift from disciplinary to multi-disciplinary (interdisciplinary, multidisciplinary, transdisciplinary, etc.) since the mid-twentieth century (You, 2017). Education is seen to be inadequately focused on the problems of individuals and communities.

When the global growth indices according to World Economic Forum (2006) and OECD (2001) reports are examined, the economic growth is attributed to innovation as a major source. When the innovation is considered, the areas such as materials science, nanotechnology, biotechnology, and informatics come to the mind first and the interdisciplinary researches among these areas become prominent (Ulusoy, 2007). Interdisciplinary studies are reflected firstly on university level education and then on lower levels of education such as secondary school, middle and even primary school. There are two main reasons lying behind this implementation: resolution of global problems not with only one discipline but with interdisciplinary methods and need for more interdisciplinary research as an impact from the changes in management and economics. In this regard, during the years 2005 and 2007, the educational programs in Turkey are amended and designed in a way to adopt constructivism approach, which aims to have the student infer meaning and structure information from the experiences they have while interacting with their environment (Açıkgöz, 2002). The Board of Education under Ministry of Education (2005) also states that the changed curriculum should be implemented in a way that both gives importance to cognitive development of students and contributes to students' positively affective conversion against the

courses, as well as prioritizing 21st century skills such as critical thinking, creative thinking, communication, entrepreneurship, investigation, questioning and using information technologies. In another report about curriculum renewal and change studies that the Board of Education released in 2017, it is emphasized once again that the change studies starting at 2005 have been completed by 2016 and a comprehensive change is made. With this curriculum form, rather than teacher-lecturing, a student-centered teaching is aimed that students could reach the information by the activities and studies that leverage on their reasoning, investigating, researching, commenting, connecting and evaluating skills. Cognitive skills such as knowledge, scientific environment, financial technologies and media literacy that are also regarded as 21st century skills are given a large share in the course contents. The significance of improving these skills, as well as not keeping the curriculum abstract and disconnected to sustain permanent and meaningful learning by relating them with daily life are highlighted.

In this sense, the importance of interdisciplinary studies that emerge with developing and changing world, as well as the ways how these studies should be applied with the curriculum changes and also at what level these methods contribute to the development of desired 21st century skills have become considerable research subjects.

The word ‘interdisciplinary’ refers to “conceptual integration of a notion in different disciplines” according to Erickson (1995). For interdisciplinary teaching, one or more disciplines gather around a problem or a topic, in short, knowledge and research methods of not only one but many disciplines could be utilized in solution to a problem (Jacobs, 1989). By this means, while obtaining more holistic and high-level thinking ability, students could start to observe the connections between concepts easier and start to restructure disorganized information in a complex problem faster and easier (Duman & Aybek, 2003).

Interdisciplinary studies, once absorbed into the curriculum and instruction, have positive impact and improvement on 21st century abilities, such as learning and innovation skills, information media and technology skills, even life and career skills (Alismail & Mcguire, 2015).

1.2. Statement of Problem

With the curricula that recently changed in 2017, context based learning is emphasized and as an example, STEM (Science, Technology, Engineering and Mathematics), which is an interdisciplinary application is brought out to science and math curricula as distinct from 2013 curricula (MoNE, 2017). However, the studies about the implementation of these curricula reveal that the sufficient weight is not given to affective objectives, as well as the cognitive objectives are limited with the comprehension levels (Erdamar, 2019; Yayla & Yayla, 2018). It is observed that the class implementations still could not move away from disciplinary conception (Yalçın, 2020). The studies also show that traditional learning is used more frequently when compared to context-based learning by the teachers. Nevertheless, especially in quantitative courses, context-based learning provides students with higher levels of motivation as well as permanent learning with real life applications (Tekbıyık & Akdeniz, 2010; Yalçın & Emrahoğlu, 2017).

In disciplinary methodology, learning by modeling frequently requires over-reliance on so-called classroom experts. While educators need to focus on specific know-how, the imaginative use of real-world problems is often missing. The modeling (disciplinary) method also leads to limited and inflexible systems of thought with tendency of more episodic and narrow perspectives.

As these studies imply, the current educational system might be perceived as reductionist, analytical, linear, and theoretical comparing to modern world orientation. However, today's world is more complex, dynamic, and practical.

Biology, physics, chemistry and, computing science or social sciences should seek interaction between disciplines not only at the research level but also at teaching levels. From an educational perspective, teaching, which divides into different disciplines, stands in contrast to the student's natural approach to exploring his or her environment and therefore provides less incentive for the student unless they have a specific personal interest in this or that subject.

To sum up, it could be seen that the interdisciplinary studies that play a positive role for the individuals to gain the desired 21st century skills and whose necessity is obvious

for solving problems with its complex and above-disciplinary structure are not at the desired applicable level when the educational system of nowadays.

On the other hand, especially when the science (chemistry, biology, physics) courses and the mathematics, named as the language of science, that are taught at the high school are considered, conducting an interdisciplinary study and generating connection over a complex problem among these courses should have priority intrinsically by natural sciences and by the fact that the answer to real-life problems could not be found by a single discipline only (You, 2017).

1.3. Purpose of the Study

This study aims to reveal the feasibility of integrating interdisciplinary methodology into education in high school science and mathematics courses and to discuss possible obstacles to the successful integration of this method into the education system. In addition, the needs, competences, and tendencies of teachers to teach with an interdisciplinary approach and the limitations that prevent the application of the interdisciplinary method are emphasized.

In order to achieve this, the research questions are formulated as follows:

1. What is the applicability of interdisciplinary approach in high school science and Math education?
2. Which factors affect the implementation of interdisciplinary approach in high school science and Math education from the perspectives of science and Math teachers in terms of its requirements, benefits and restrictions?
3. What are the opinions of science and Math teachers about teacher education of interdisciplinary approach?

1.4. Significance of the Study

There are many studies on interdisciplinary practices at almost all levels of education. For example, Gerke (2017) discussed interdisciplinary practices at primary school level by exploring teacher perceptions and practices abroad while Aslan and Karakuş (2017) studied current situation regarding interdisciplinary teaching in primary schools in Turkey. Similarly, Aytar (2016) examined science interdisciplinary practices in a

public middle school in Turkey and Aksoy (2020) examined integration of science education with Math, technology and art education in middle schools. Moreover, Lenoir & Hasni (2016) studied perspectives and issues related with interdisciplinary approach in primary and secondary schools abroad.

In the literature, there are not enough studies on the applicability of interdisciplinary applications in high school mathematics and science lessons, especially in private schools in Turkey even though literature says that when compared to public schools, the resources as well as the social and academic institutional motivations could be more in many private schools (Gürler, 2020). The existence of these resources could provide motivation for planning and implementing of interdisciplinary studies.

In this respect, the goal of this thesis is to research on the feasibility of interdisciplinary studies among physics, chemistry, biology and mathematics courses at high-school level with regard to the teachers' perspective under the conditions of a private school in Turkey, along with its potential pros and cons, as well as the difficulties faced in planning and implementation phases. Since this thesis focuses on the implementations of interdisciplinary studies at high school level, it emphasizes the complications that mostly appear throughout the process. As a case study, the whole research is performed around a Private High School located in Ankara, Turkey.

The findings of this thesis can serve to educational institutions by providing information about the readiness of teacher, student and school for interdisciplinary studies planned to be performed in future and they can act as pathfinders for the teachers in the design of an interdisciplinary educational program whether in-house or outsourced.

This study, like all other studies about interdisciplinary programs, suffers when resources are limited. The integration of interdisciplinary education into the system depends on variables that are specific to each particular case: the type of interdisciplinary introduction, the extent and nature of the transition, the number of students involved, the level of teaching skills and previous educators training, the design and curriculum development frameworks, allocated time and money etc. Besides being the determinants of the level of interdisciplinary integration, these variables also determine the scope of this research.

The research continues with the Chapter II, which includes literature review about the interdisciplinary education. In Chapter III, further information is given regarding the methodology applied and the data used in the research. The result and conclusion will be discussed in Chapter IV and Chapter V.

1.5. Definition of Terms

The following are some key terms that need to be clarified:

Discipline: A specialized field of study, a branch of knowledge distinguished by the uniqueness of its content and methods (Yadav & Lakshmi, 1995)

Interdisciplinary teaching: A method of investigating a theme, issue, question, or topic by combining elements from other academic disciplines (Newell & Green, 1982)

High School Science Education: Science learning in high school, including the physics, chemistry, biology (Mensah, 2011).

Mathematics Education: The activity of teaching and learning mathematics in order to solve issues by understanding the essential algorithms and formulas for calculations (Ololube, Kpolovie & Makewa, 2015).

CHAPTER 2

LITERATURE REVIEW

The concept of interdisciplinary has become more common in policy, practice, teaching, and research. With the current demand of the world, interdisciplinary methodology becomes more inevitable and desirable. This literature review is to provide a general description and evaluation of current field studies, publications in interdisciplinary methods, and other disciplinary methodologies as well.

Although the literature review analyses, the methods and the outcomes starting from the beginning of interdisciplinary methodology in this study, it mainly focuses on finding research questions. Also, this study aims to explain the big picture of interdisciplinary methods as well as the effects of students and instructors. This thesis prefers to examine different authors at different times, depending on the geographical location and the specific aspects of the discipline that are being addressed.

In the literature review, firstly, a structure of disciplinary methods in education is presented to create a common ground for future discussions after introducing the evolution of interdisciplinary methodology, the definition and the importance of this model. Then, the integration of the curriculum, feasibility, and the challenges of this concept is clarified.

2.1. Motives of Merging Disciplinarity in Education

The world is developing and changing socially, economically, technologically politically. This situation also changes the balance of many systems in the world. With the advancement of technology and the ease of access to information, there is a transition from an industrial structure to a globalization, innovation and knowledge-based economic structure (Roberts & Owen, 2012). The main purpose of education is to prepare students for this changing and developing real life, that is, not individuals who memorize information, but individuals who can adapt to change, learn how to

access information, solve problems and are creative (Aybek, 2006). This means that the education system should improve with this changing world and evolve to meet the needs and become ideal, and an ideal curriculum should be formed not only according to the transmission of academic disciplines and cultural values, but also according to the interests and needs of the students (Dewey, 2008). In the 21st century, it is seen that both student needs and student profile have changed. There are many studies on the fact that the skills required for individuals to lead their lives, adapt to life and be successful in business life have changed today, and in these studies, the necessity of education systems to gain these skills is emphasized (Partnership for 21st Century Skills, 2009; OECD, 2018). In short, these skills express not only the development of students in school life, but also the development of cognitive, behavioral and emotional expertise that can improve themselves and adapt to changes (Cansoy, 2018).

Curriculum practices in the Turkish education system have also been criticized for not developing an inquiring perspective, not being related to daily life, being rote learning based and teacher-centered. For this purpose, radical changes were made in the curriculum in 2005 and student-centered curriculum based on the philosophy of constructivism began to be developed (Özdemir, 2005). With these studies, which were generally completed in 2016 by examining the curricula of different countries whose education systems are considered successful, by scanning domestic and international academic studies, and by collecting opinions from teachers, administrators and universities, the current curricula are updated in a way that will meet the changing needs of individuals and society, in line with innovation and developments in learning and teaching theories and approaches. The knowledge, skills and attitudes related to the competence skills that are expected to be gained by the students with the renewed curricula are listed in 8 items under the title of "Turkey Qualifications Framework": Communication in mother tongue, communication in foreign languages, mathematical competence and basic competences in science/technology, digital competence, learning to learn, perception of initiative and entrepreneurship, social and public competencies, cultural awareness and expression (Board of Education, 2017). The announced Turkey Qualifications Framework is also similar to 21st Century skills published by other organizations in the literature (P21 (Partnership for 21st Century Skills), AACU (American Association of Colleges and Universities), NRC (National Research Council), ISTE (International Society for

Technology in Education), NCREL (The North Central Regional Educational Laboratory)) (Cansoy, 2018).

In the principles of implementation of national curricula, MoNE (2018) mentions the importance of original and creative assessment and evaluation tools that teachers will choose while applying the curriculum, rather than the content of the curriculum in gaining 21st century skills to students, and makes several suggestions that teachers should consider in the selection of these tools:

- Individual differences should be taken into account and a uniform evaluation method should not be used.
- A multi-focused assessment-evaluation should be the basis and these practices should be carried out with the active participation of the teacher and the student.
- Cognitive measures alone should not be considered sufficient in education.
- Since the characteristics of individuals such as values, attitudes and success can change over time, applications that take into account the changes in the student and the process spread over time should be used instead of applications that develop and measure competences in a single time.

Briefly, in education systems where gaining 21st century skills has become very important for the welfare of both individuals and societies, it is emphasized that instead of presenting stereotypical information to students with teacher-centered methods, by using student-centered methods, it is necessary to abandon classical, standardized methods in assessment practices (Sawyer, 2008).

In addition to the effects of the changing world order on educational practices, researchers have increased their research on how individuals learn better, how high-level thinking skills can be improved and how learning motivation can be increased. The points that students do not know why they learn the subjects, the loose connection of the subjects with real life, while the students perceive the world in a holistic way, the fact that what they learn at school is not related to this integrity have negative effects on the motivation of the students (Yıldırım, 1996). On the other hand, examining a problem holistically with related disciplines and seeking solutions to the problem not only increases the motivation of the student but also improves critical thinking and communication skills. (Cowden & Santiago, 2016). In addition, real-life

problems might not be solved with a single discipline, and even disciplines might be related to other disciplines within themselves (Jacobs, 1989; Perkins, 1994). A scientist working in the field of chemistry also benefits from the field of physics, similarly a salesperson or consultant researching the market of a product does not only review the economy of that country, but also considers and researches factors such as the country's history, development, culture, etc. Also today, even disciplines continually change; it can evolve, grow, and decline. It shapes temporal dimensions or external dimensions, such as national and institutional. So education must encourage the development of a critical mass of people who are more creative and have better thinking skills. If educational institutions continue to teach pupils content without considering how quickly that knowledge becomes outdated or useless, education will tend to fail (Brennan, 1997).

The use of interdisciplinary education and practices in educational implementations has gained importance due to the change in education systems according to student needs, the use of student-centered methods and the gaining of 21st century skills to students, and the fact that the disciplinary approach in education is not sufficient in solving real world problems (Aybek, 2013; Jacobs, 1989).

2.2. Definition of Interdisciplinary Methodology in Education

When the expansion of the concept of discipline is examined before the concept of interdisciplinary, Piaget (1972, as cited in Jacobs, 1989) defines the concept of discipline as a teachable knowledge community with its own educational infrastructure, processes, methods and content areas. From this definition, it can be deduced that the way of learning every discipline or the methods and techniques that increase knowledge in every discipline are not the same. All kinds of disciplinary information that students learn at school is meaningful and valuable, but it is easier and more meaningful for students to associate the information they learn with the world they live in, when taught in conceptual frameworks (Doğanay & Gürkan, 2016).

While Yıldırım (1996) explains interdisciplinary education, which tries to shape the relationship between disciplines according to student needs, as the integration of disciplinary knowledge and skills that can illuminate a certain concept such as a problem or subject, Jacobs (1989) describes this approach as the conscious use of the

knowledge and methods of two or more disciplines in the examination of a concept, subject, problem or experience. Wiggins (2001, as cited in Baker, 2007) states that real life cannot be separated by subjects, and schools preparing for real life cannot be disconnected from life itself, and therefore, he likens interdisciplinary studies to the idea of cognitive apprenticeship.

Jacobs (1989) states that disciplines can be combined with different methods other than interdisciplinary: In multidisciplinary, different disciplines are tried to be examined by protecting the perspectives of the disciplines, unlike interdisciplinary; in cross-disciplinary, a discipline is examined in terms of other disciplines; in transdisciplinary, on the other hand, together with other disciplines, it is tried to create a new discipline understanding by going beyond the scope of the disciplines, industrial engineering can be given as an example of this combination (Yalçın, 2020). Figure 2.1 summarizes five different methods of combining disciplines.

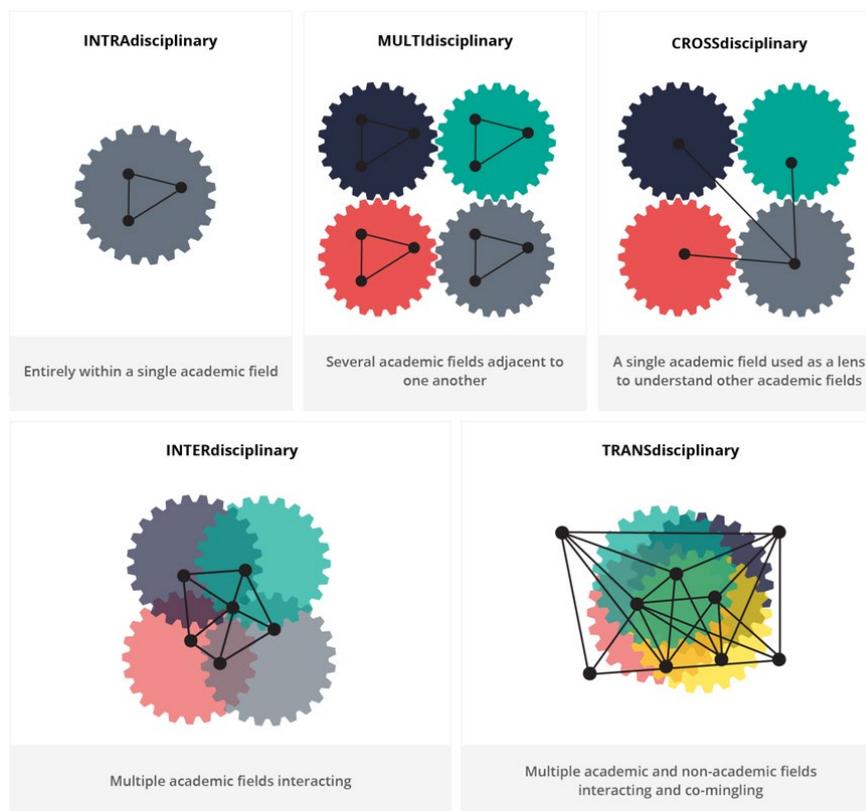


Figure 2.1 The Difference Between the Disciplinarity (Mehta, 2019, URL)

2.3. Historical Evaluation and Theory of Interdisciplinary Methodology in Education

Although interdisciplinary teaching seems to have started to be implemented in the United States in the 1920s, its emergence as an idea dates back to much earlier times (Klein, 1996; Ellis & Fouts, 2001). Newell (2013) calls this period “pre-theory” and states that in that period, the definition and scope of the interdisciplinary concept are tried to be made and its integration into education is not the primary concern. Johann Friedrich, a German philosopher in the 19th century, talked about this methodology with the idea of unifying the programs, and further, it was shown that, thanks to this idea, disciplines or knowledge could be handled more holistically without overpowering each other, and that it could be used by teachers to embody or update the subjects in education (Drake & Rebecca, 2004).

When interdisciplinary is examined theoretically, in Newell (2013) theory, it is stated that "complexity" lies at the base of the theory and that interdisciplinary studies deal only with complex phenomena, therefore complexity also needs interdisciplinary. In the content of interdisciplinary theory, apart from complexity, there lies “perspective taking” (exploring an issue, problem or phenomenon from different perspectives and capturing a holistic perspective), “common ground” (integrating conflicting assumptions, theories, concepts, values and principles in disciplines) and “integration” (understanding a problem by integrating the best elements of concepts, assumptions or theories) (Repko & Szostak, 2017).

When the theoretical foundations of interdisciplinary education are examined, it is observed that they depend on Dewey's student-centered school model, which focuses on the creativity and experience of the student, attaches importance to individual needs, and aims to combine life and education, as well as Piaget's constructivist education theory, which advocates that the student builds his own knowledge by experience. In addition, it can be said that interdisciplinary studies based on the establishment of relationships between concepts are also based on brain-based learning theories, due to the studies on the brain to establish relationships between subjects or learn better when it sees connections (Head, 1997; Ellis & Fouts, 2001, as cited in Coşkun, 2009).

Interdisciplinary education practices in Turkey came to life with the establishment of Village Institutes in the 1940s. In the village institutes, pre-service teachers both built their own classrooms and workplaces. Moreover, by learning the necessary general knowledge and vocational information, and doing agricultural studies, they gained the necessary skills for the development of villages and agriculture. With the first official curriculum published in 1943, it is seen that the philosophy of constructivism is at the foundation of the curriculum. A living community school was created with courses in arts, culture and agriculture as well as technical courses (MoNE, 2021).

With the closure of village institutes, interdisciplinary education was reconstructed with the constructivism approach in 2005 and it came to the fore again today with new curricula based on student-centered education. Today researches and practice studies are carried out increasingly by both researchers, teachers and institutions (Durmuş, 2019).

2.4. Designing and Implementation an Interdisciplinary Study in Curriculum

When you are out walking, nature does not confront you for three quarters of an hour only with flowers and in the next only with animals.

Lionel Elvin

Teaching with interdisciplinary practices should not be perceived as an artificial combination, such as teaching subjects from different disciplines one after the other during a course. In an interdisciplinary study, while the disciplines are organized in a meaningful way around a concept or problem, it both facilitates the learning of disciplinary knowledge and reconciles real life with education (Yıldırım, 1996).

In order to prepare an effective interdisciplinary study or curriculum, the principles that Jacobs (1989) presented in five stages but later on, added two more items (2004) that can be seen as a feasibility study before starting to program an interdisciplinary study can be summarized as follows:

- **Prologue part I:** It is necessary to have information about the students in order to determine the needs of the students well. For this reason, before starting an interdisciplinary study, it is recommended to conduct research on the target population such as age, size, targeted standard, special needs.

- **Prologue part II:** The characteristics of the environment in which the interdisciplinary practice will be made and some other conditions affect the quality of the practice. For this reason, there are several factors to be taken into account such as how much time is needed for the development and implementation of interdisciplinary practice, whether there is a factor that will prevent learning, whether the practice will be carried out during class hours or in another time period, the suitability of the environment in which the study will be carried out, whether the teacher creates a common schedule in cooperation with other discipline teachers for the planning and development of the practice.

Step 1. Choose a format:

At the first stage of planning an interdisciplinary study, the environment conditions where the education will take place should be evaluated and it should be decided whether an interdisciplinary application should be chosen as the curriculum format according to the student profile.

Step 2. Draft a title and an organizing center:

In the second stage, a title that will attract the attention of the students is selected, and under this title, the subject, theme and problem of the study are determined in more detail.

Step 3. Brainstorm by using the concept wheel:

The subject of the study or the problem is drawn in a circle, and the disciplines to be associated with the subject are written around this circle, and brainstorming is done by all the teachers related to these disciplines together with their students.

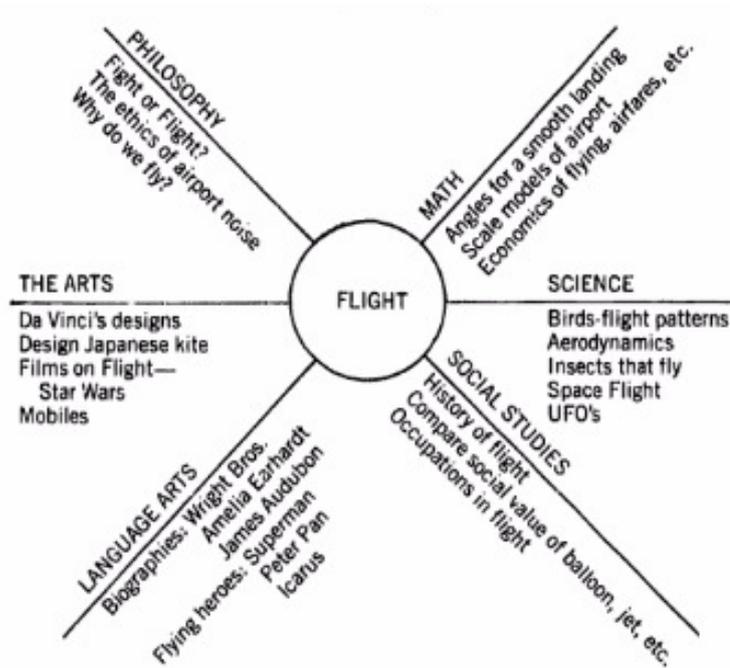


Figure 2.2 Example of an Interdisciplinary Concept Model (Jacobs, 1989, p. 57)

Step 4. Develop essential questions:

In the fourth stage, basic (essential) questions about the daily life should be asked that will enable students to discover the connections between disciplinary areas, determine the limits of the study, encourage high-level thinking, attract attention, and provide in-depth learning.

Step 5. Integrate skills and assessments into the essential questions:

In order to evaluate the effectiveness of the program, the learning process and the learning products, an evaluation process is established in accordance with the evaluation standards determined at the beginning of the planning. In this process, methods such as peer and self-evaluation can also be used.

Step 6. Plan the day-to-day activities:

At this stage, the daily activities of the interdisciplinary study are designed by considering the basic questions of the study and their relevance with the skills expected to be acquired by the students. Since process is important in an interdisciplinary study,

daily activities should be chosen in such a way that students benefit from this process at the highest level. Considering the time planned in prologue section together with the number of students and their characteristics, answers should be sought for questions such as whether a group study will be designed, whether a field trip or laboratory use is needed.

Step 7. Do the final reviews:

In the last stage, the previous stages are reviewed. For example, questions such as whether the daily activities or content practices prepared in the later parts of the study are compatible with the achievements determined at the beginning of the study or are they compatible with the title should be asked and checked. In summary, the plan of the interdisciplinary study is evaluated.

Yıldırım (1996) mentions some principles that should be considered during the planning process and in the selection of the subject in order to carry out an effective interdisciplinary study: First, the developed study should be closer to being practical rather than theoretical and should be planned around a topic that addresses the current and future needs and development of students' skills; secondly, the subject of the study should be of an interdisciplinary nature, that is, it should not be revolving around a single discipline keeping the other disciplines as auxiliary; thirdly, the planning of the study should be done properly and teaching the objectives with an interdisciplinary study should be more effective than teaching with disciplinary education; fourth, a discipline should not be included simply for the sake of participating, it should have a serious impact on the study; and lastly, through an interdisciplinary study, not only the desired subject objectives but also other 21st century skills that students will acquire should be taken into consideration, and activities that will highlight these skills should be given importance in the curriculum design process.

Newell (2013), on the other hand, mentions that while conducting and teaching interdisciplinary studies, it is necessary to accept that each discipline in the study reflects the truth in its own field and to reveal the common and subject-strengthening aspects of the disciplines. He also adds that the disciplines should not be superior to each other or should not create compromises and teachers should guide students, not act like experts.

2.5. Importance of Interdisciplinary in Education

Study the science of art. Study the art of science. Develop your senses--learn how to see. Realize that everything connects you to everything else.

Leonardo Da Vinci

One of the points where the education system is in conflict with today's world is the fact that it is based on fragmentation. By educating students with completely disjointed disciplines, it should not be expected from them to deal with the multifaceted nature of the business world (Jacobs, 1989). The interdisciplinary approach helps to understand a complex problem or subject by providing the effective use of discipline-specific approaches, methods, knowledge and skills, and creates a real-world image by providing a holistic understanding of the subject (Yıldırım, 1996; Suraco 2006). Interdisciplinary teaching enables students to transfer knowledge and put it into practice, and in this way, the disciplinary learned information becomes more meaningful to the students and the abstract concepts they see in school begin to become concrete (Çelik & Buluç, 2018; Yıldırım, 1996). The students start to have a more positive attitude towards the lesson and the school and their motivation increase (Boyraz, 2015; Yarımcı, 2010).

Problem solving skills and research skills of a student working on an interdisciplinary project increase (Yalçın, 2013). In addition, interdisciplinary education provides a more permanent learning and increases success in the course (Alp, 2010; Budak & Coşkun, 2009). As students learn to look at the subject from different angles through an interdisciplinary study, they begin to make sense of the world they live in from different perspectives, and they can develop the ability to use these skills by discovering their own abilities (Drake & Burns, 2004).

Students begin to gain a context-based perspective, and by noticing the contexts between information, they can establish cause-effect relationships more easily (Dezure, 2000; White & Carpenter, 2008).

According to Smith and Karr-Kidwell (2000), in an interdisciplinary study, students use both sides of their brains for learning and such studies enable them to do more critical-thinking. Also, there are studies that show more improvement in the affective

and cognitive development of students compared to the lessons created with the traditional method (Aydın & Balım, 2005).

Interdisciplinary education provides certain contributions not only to students but also to teachers. When planning a student-centered interdisciplinary project first, teachers challenge themselves to explore new teaching and learning techniques and try to find original, motivating activities. They help students discover their talents and the professional motivation of the teachers begin to increase (Demir, 2008).

Moreover, it is possible to see the beneficial scope of interdisciplinary education in the diversity of the curriculum. According to Rodrigo (2017), students gain from a subject-centered approach because they are inspired by lecturers who are subject specialists. It can, however, lead to inactivity and a lack of integration. Meanwhile, the learner-centered approach gives students more opportunity to participate in learning, increase their autonomy, and build a strong feeling of accountability and responsibility. However, it places a significant responsibility on instructors in terms of providing assistance and effective communication to pupils. Finally, the problem-centered model demonstrates a highly practical approach to learning that motivates students to take a more in-depth approach to learning and improves retention and higher-order thinking abilities. On the contrary, preparing a problem-based learning assignment with a high degree of value and application may be time demanding and needs competence from instructors. In a nutshell, each of these has both flaws and advantages (Ornstein & Hunkins, 2018). A mix of the three may be the most effective way to meet the demands of students in the 21st century and the effects of these three approaches can be seen in interdisciplinary education.

2.6. Current Problems of Application of Interdisciplinary Studies in Turkey

Many nations struggle with their national educational agendas to correlate curriculum practices from social, economic, and political perspectives with the need for national and global continuity. According to the results of PISA (Programme for International Student Assessment), developed by the Organization for Economic Cooperation and Development (OECD) in order to improve the quality of education and to examine the effects of education policies on students, although Turkey has shown a serious rise since 2015, it is still below OECD average in reading literacy, mathematics and science

(OECD, 2018). In addition, student well-being is among the lowest levels in OECD countries (OECD, 2018). The expected benefit from the education system cannot be achieved in the short term, and this also has negative consequences in the training of manpower, which is one of the next steps of education (Şener, 2018).

In the study of Yeşil and Şahan (2015), in which they touched on the problems in the Turkish education system, the most important problem in the education system, according to the views of teachers, was the "understanding of education". Teachers criticize the fact that the education in schools is still teacher-centered, exam-oriented and based on rote learning, and that students cannot apply what they have learned in real life. The second problem is stated as "curriculum". Curriculum has been criticized for being implemented with an exam focus, for making students lazy by memorizing due to standardization, for not encouraging students to do research, for being equipped with unnecessary information, for not keeping up with time, for changing suddenly and frequently, and for not being clear and unambiguous. Another important result of the research is the "teacher theme". It has been stated that the reason for a rote-based education is not only the curriculum or the understanding of education, but also the teacher. Teachers' desire to take the easy way has been criticized as they only ask what they teach in exams, leading the students to memorization again, do not improve themselves, and see themselves as the owner of absolute knowledge.

Another reason why teachers canalize memorization is shown as the national exam. The fact that the education system is not based on talents and skills, and that standardization exams are only multiple choice pushes the teacher from different assessment methods to classical assessment methods such as multiple choice and memorization (Neyişçi, Turabik, Gün & Kısa, 2020).

Örücü (2014) similarly obtained negative opinions about the Turkish education system in her study. The reason for the complexity and dysfunction of the education system is its political structure, routine processes, resistance to change, mechanical organization, and teachers' lack of autonomy.

Moreover, when the student-related problems are examined, it has been observed that the students' motivation is low, the student does not care about the subject if it is a subject that will not come out in the national exam, the student attending the class in

blocks for 8 hours gets away from the outside life with the homework given constantly, and the parents are indifferent and ignorant about the education their children receive. (Şener, 2018).

In summary, studies show that there are negative aspects in the perception, curriculum, teacher, student, parents and administrators components of education during the implementation of constructivism-based, student-centered curricula that started to change in 2005 aiming to provide students with 21st century skills. Factors such as the teacher-centered education's still being premise, the use of traditional standardized assessment methods, and the existence of disciplinary and rote-oriented education in blocks show that our education system continues to operate away from the interests and skills of students and lag behind in bringing students the necessary skills to prepare for the global world.

2.7. The Problem of Preparing a Curriculum with Interdisciplinary Perspective

The qualities of a successful interdisciplinary study can be mentioned before the problems that may be encountered during the preparation and implementation of an interdisciplinary study since the absence or lack of these qualities will negatively affect the process of the study. Principally, there is a requirement of a professional study and planning for the feasibility of an interdisciplinary study. Aslantaş (2012) mentions the characteristics that a successful interdisciplinary work should have:

First of all, the instructor team that prepares the interdisciplinary work must have training or must be specialized in this field, and these people should be able to work in collaboration with others and be compatible. It is necessary to value information sharing and opposing views during the study to see the issue or problem separately from the perspective of the disciplines participating in the study, but at the end not only to collect information about the subject, but to reach a holistic solution to the issue.

Gatewood (1998, as cited in Duman & Aybek, 2003) emphasizes that in order for an interdisciplinary teaching to be successful, teachers should meet once a week to discuss the curricula and discuss which subjects in which disciplines are more compatible with each other in order to carry out an interdisciplinary project. In this case, one of the factors that can create a major disadvantage in the planning of an interdisciplinary study is the teacher's low knowledge about their own interdisciplinary contexts (Ayvacı, 2010; Özaydınlı & Kılıç, 2019; Coşkun, 2013; Aybek, 2000), the

lack of education or knowledge about the planning process of interdisciplinary projects (Yolcu, 2013; Cura & Ercan Yalman, 2019) and another is that more time and effort than traditional applications would be needed throughout the project (Jacobs, Hannah, Manfredonia, Percivalle & Gilbert, 1989; Karakuş & Aslan, 2016). In addition, the fact that teachers must come together constantly in order to carry out the practice successfully is considered as a practical barrier and problems may occur in organizing the meeting, creating a common language and knowledge, and working on the project as a group (Domino, Smith & Johnson, 2007; Özhamamcı, 2013).

Like the importance of providing students with 21st century skills in education, teachers who play an active role in gaining these skills are expected to have some professional competencies in the 21st century. The International Society for Technology in Education (ISTE), founded in partnership with Microsoft and Kaltura, emphasizes the need for teachers to have certain standards that will enable them to question the traditional approaches they use, enable their students to drive their own learning, and lead them to become empowered learners. These standards are as follows:

- The teacher should be a “learner”: They should discover and apply pedagogical approaches. They should participate in local and global networks related to education and support their professional interests. Student should follow the latest research on learning outcomes.
- The teacher should be a “leader”: The teacher should be a pioneer to colleagues in the identification, exploration, evaluation, curation and adaptation of new digital sources and learning tools. They should ensure that the students benefit equally from learning opportunities for different educational needs.
- The teacher must be a “citizen”: They must create a leaning culture that will promote the curiosity and critical examination of the students and act as models in being safe, legal and ethical in terms of the digital tools usage as well as the protection of intellectual rights and properties.
- The teacher should be a “collaborator”: Teachers should take the time to come together with both their colleagues and students in terms of improving practice, discovering and sharing resources, ideas and solving problems. Tools that will increase students' real-world learning experiences should be shared locally and

globally. Teachers should communicate with students, parents and other stakeholders about the student's learning.

- The teacher should be a “designer”: The teacher should be able to prepare differentiated course materials and authentic learner-driven activities that will support learning and engage the students in the course, based on their interests and needs.
- The teacher should be a “facilitator”: The teacher should develop a culture in which students can take responsibility for their own learning, both individually and in group work. They should present learning opportunities that will challenge students and be a model for the formation of creative ideas and nurture the creativity of their students.
- The teacher should be an “analyst”: Teachers should analyze student learning outcomes in order to improve their instruction and teaching in general. (ISTE, 2021)

Gümüş (2019) stated in her study that teachers will face some difficulties due to the rapid changes in the learning environment, student profile, teaching techniques, social life, and business life in the 21st century, and in overcoming these difficulties as well as educating students to adapt to the changing social structures, they indicated that teachers should have skills such as leadership, cooperation, professional and digital development follow-up similar to ISTE. The skills expected to be possessed by the teacher today are of great importance in the implementation of an important application with both challenges and outcomes, such as infusing interdisciplinary practices into the curriculum or creating an integrated curriculum.

Apart from teacher’s skills, in the study of Al Salami, Miranda, and Makela (2017) in which they examined the change of teachers' views in an interdisciplinary project application, among the problems in practice, the teachers indicated that the students had little background knowledge and skills on this subject, the time was limited for both students and teachers, and it was hard for teachers to get together.

In an interdisciplinary study, the inconsistencies in the subject order of the participating disciplines in the MoNE curricula can negatively affect the study (Özaydınlı & Kılıç, 2019; Güneş, 2007; Yolcu, 2013). The lack of context-based

associations in the contents of the curriculum can also have negative impact on the feasibility of the study (Bozkurt, 2012; Turna, Bolat & Keskin, 2012).

Another factors such as the large number of classrooms, especially in public schools, and the lack of materials in the school (lack of technological devices or laboratories, etc.) can similarly affect an interdisciplinary study in a negative way (Sağdıç & Demirkaya, 2014).

2.8. Constraints of Interdisciplinary of Education

Recently, with the increase in interdisciplinary studies, especially at the university level and afterwards, some critical studies on the approach have also emerged. Among the studies on the increasing uncertainty of disciplines with the popularization of interdisciplinary studies, Geertz (2005, as cited in Değirmenci, 2011) argues that disciplinary disorganization has started to occur. However, it is stated that this situation arises from the fact that interdisciplinary studies are not properly structured. According to Cone (Cone, Werner, Cone & Woods, 1998, as cited in Arslantaş, 2006), interdisciplinary practices can have some disadvantages both by nature and by being incorrectly constructed:

- Arranging the curriculum with interdisciplinary approaches may result in the removal of some content from the disciplinary curriculum.
- Teacher's concern about losing an important content in his/her own field may cause the teacher to focus on more effectively teaching a content that he/she considers more important.
- In interdisciplinary learning, it is sometimes inevitable for one discipline to overshadow another discipline.
- Teachers who are not academically competent in their fields may have problems in associating concepts and skills, so the objectives of interdisciplinary work may not be designed according to the interests and needs of the students.

2.9. Studies on Interdisciplinary Approach

2.9.1. Related studies in Abroad

Hurley (1999) made analytical descriptions of quasi-experimental studies to support or refute the educational betterment through interdisciplinary mathematics and science. Interdisciplinarity was explored in two aspects, philosophical and pedagogical, utilizing two methodologies, meta-analytic and qualitative. Overall 34 studies that were collected as a result of a literature review were addressed for this purpose. According to the findings of these studies, there is a growing trend toward a wide range of viewpoints on the nature of interdisciplinary education. The results from qualitative methodologies show student improvements in thinking skills and reveal that instructor, administration, and teacher education are critical to the interdisciplinary program's success.

Marrongelle (2001) conducted a study to examine the manner of students participating in an integrated Calculus / Physics course. The aim of the study was to investigate the utilization of these students' understanding of physics for conceptualizing the calculus concepts. For this purpose, 8 first year college students were selected and the data was collected via semi structured interviews, observations, in-class notes, assignments and examinations. The outcomes from this investigation show frequent usage of physics concepts among the students in their meaningful conceptualization. Another finding from the research is that the students enrolled in this study own more abundant conceptualizations of calculus concepts.

Suraco (2006) aimed to determine the interdisciplinary relationship of arts classes with other disciplines and the necessity of arts integration into education. By utilizing qualitative research methodology, the views from a group of 67 people were collected. Within this group, there were not only teachers but also school administrators and music experts. Moreover, 1400 students from elementary and middle school participated as the sample for evaluating themselves through provided rubrics. As the outcome of the study, it was found out that students combined their knowledge with research skills and were able to make sense of them.

In his doctoral study, Fleming (2007) aimed to investigate the relationship between science and art, which seem different but have strong connections throughout the history. The thesis is a multi-method case study examining the positions and perspectives towards science and art that were obtained from 26 candidate elementary teachers. In this study, the data were collected by methods of pre-tests, post-tests, observation and interviews. The results show a substantial increase in self-efficacy and interest in teaching science and art as well as penetration of creativity and imagination in the area.

Van der Veen (2007), in his doctoral study on the integration of the disciplines of art and physics, investigated two main subjects. First of which was how aesthetics and creativity could be included in college level physics education by not giving up on mathematics. The second was about creating access to physics for both physics and arts students as well as future teachers. For this purpose, a case study was carried out with 11 students, 7 of whom were studying physics and 4 of whom were studying arts. It is emphasized that the positive results obtained from this study are worthy of further research and it could contribute to physics studies for teachers and could become a basis for media, art and technology programs.

“The Annual Three Day Interdisciplinary Curriculum Project” is a curriculum project whose critical analysis was made by Gatto (2008) in the 2003-2004 academic year with 1760 high school and 146 university populations. The qualitative study in which 21 teachers and 8 administrators were selected by random sampling method is a case study and data were obtained by focus group interview method. One of the most important result of the study is the contribution of the project to teachers' speaking a common language around a chosen theme in the current school year.

Cai and Sankaran (2015) discussed how an interdisciplinary curriculum with multidisciplinary faculty might promote critical thinking, as well as the implementation of an experiential short-term study abroad program in China. The program was designed on a framework employing two interrelated techniques – theme-based interdisciplinary curriculum and cultural immersion – to serve the educational purpose of critical thinking and to meet the criteria particular to each subject. According to the study; the three concepts that guided the development of the

theme-based interdisciplinary curriculum were the ability to pose great questions that included drawing knowledge and abilities from each field, acquiring global awareness, and growing glocal awareness. Site visits, events, and assignments were carefully chosen to provide cultural immersion. Formative and summative evaluations were used to examine students' experiences, reflections, and applications. As a result, this thematic interdisciplinary approach significantly contributed to the development of analytical and critical thinking skills among the students, promoting their willingness and ability to apply these skills into real world problems.

According to the study of Bell, Morrison-Love, Wooff & Mclain (2017); teachers' knowledge, comprehension, and pedagogical implementation of STEM education is integrally related to the subsequent success of STEM delivery in their own practice and the deficiencies in a teacher's knowledge and understanding could lead to limitations in student's learning. The study investigates the methods that design and technology teachers gain new STEM knowledge as well as the ways that teachers absorb and transfer this understanding into practice for the middle education in England and Wales. Utilizing the philosophical area of symbolic interactionism, the study employs an abductive technique in which participants are encouraged to link design and technology within the framework of STEM education. Emerging results are examined in light of their potential to assist teachers' professional development in order to improve STEM literacy and ensure design and technology's place as a valuable topic in a twenty-first-century curriculum.

2.9.2. Related studies in Turkey

Çimen (2002) examined the success factors of interdisciplinary teaching on ecology with a group of 40 high school students in her doctoral study. An interdisciplinary, student-centered ecology education was given to the experimental group of 20; the other 20 control group was given teacher-centered education with classical methods. As a result of the data collected from both students and biology teachers, it was observed that conceptual learning was better in students who learned the subject of ecology with interdisciplinary teaching compared to those who learned with classical methods. It was stated that teachers need both ecology field knowledge and in-service training on alternative, student-centered learning methods.

Derviřođlu (2003) applied a questionnaire to 67 biology teachers and 25 school administrators in her quantitative study evaluating the interdisciplinary teaching approach in secondary school biology. According to the results of the survey, teachers stated that the national curriculum was not suitable for interdisciplinary teaching and they needed more time for such applications. Similarly, administrators stated that the structural conditions were not suitable for interdisciplinary studies.

In the study of Diker (2004), the impact of interdisciplinary projects on students' logical thinking skills and learning processes are analyzed among 10th graders. With the participation of 8 students, 4 teachers and 4 parents; nested single case pattern from case study patterns is used along with the logical thinking tests for identification of changes in students' skills and paces of learning. Prior to the implementation of interdisciplinary project, students indicated that they were not able to relate various courses with each other in a way to apply information gained in one discipline to another. As the result of study, a positive change was observed between the pre-tests and post-tests of students and teachers were able to better comprehend interdisciplinary approaches.

Aktürel (2005) studied the teaching of the life sciences course with an interdisciplinary approach and worked with two hearing-impaired students for two weeks. According to the results of the study, teaching with an interdisciplinary approach increased students' writing skills and students showed improvement in their subject knowledge and oral language use.

Çıray (2010), in her study with 104 8th grade students at different academic levels, investigated the quality of teaching with an interdisciplinary approach towards science and technology lessons. According to the results of the research, teaching with an interdisciplinary approach was effective in the learning level of students with high academic achievement.

In her qualitative and quantitative study conducted with 84 pre-service music teachers, Turna (2010) investigated the association of concepts that have the same meaning in music discipline and physics discipline as well as the relevance of these concepts to teaching with an interdisciplinary approach. According to the results of the research,

pre-service teachers do not know the concepts that have the same meaning in music and physics and they need training in interdisciplinary applications.

In her post graduate thesis, Özhamamcı (2013) aimed to present the views of elementary and middle school teachers regarding the interdisciplinary applications and to find out whether these views change depending on variables such as gender, experience etc. By using maximum variation sampling method, 345 randomly selected teachers from 30 different schools participated in the research in which interdisciplinary teaching approach scale was implemented. As the result of this research, teachers found the interdisciplinary applications highly helpful, especially in terms of helping students comprehend the subjects. Another interesting finding was that teachers did not cooperate with the teachers of other disciplines even though they mostly perform interdisciplinary applications in their classes. Moreover, they do not find instructions about interdisciplinary applications sufficient in elementary and middle school curricula. In line with these findings, suggestions were made to conduct curriculum developments studies to support interdisciplinary applications.

Yalçın (2013) conducted a research to identify the biology learning levels of students by using literary approach in association with interdisciplinary applications and to improve their success by fostering imagination. For this purpose, pre-test post-test experimental design with control group was applied to 52 students from Nevşehir Science High School. The students were divided as experimental and control groups. The experimental group students were asked to write stories or poems regarding subjects in biology and they were evaluated by the same group. The results revealed that experimental group students were more successful than control group students.

Kanathlı and Çekici (2013) emphasized the fact that there was no research about the interdisciplinarity of Turkish education even though there were many theoretical and practical interdisciplinary studies in other subjects. In their study, it was aimed to describe the possibilities of interdisciplinary applications in Turkish education in line with the expectations of current educational approach. For this purpose, several subjects that could provide interdisciplinary cooperation with Turkish education such as information technologies, music, media literacy, science and drama were selected for analysis in terms of temporal parallelism and gradualism. With the vision of

supporting Turkish education by means of these subjects and their interdisciplinary harmony, as a result, the study confirms the interdisciplinary convenience of Turkish education.

In order to identify the views about the implementations of interdisciplinary approach and intelligence theory, Çelik (2014) researched whether there are significant differences between these views from teachers and their personal characteristics. With participation of elementary school science and technology teachers from Eskişehir province, the study was performed in a descriptive nature by using survey model. The results showed that the views about interdisciplinary education were differentiated significantly among male and female teachers, in favor of male teachers.

In the study of Doğan (2014), the impact of interdisciplinary education on geography courses was examined via case study from qualitative research designs. A sample of 14 students from 11th grade was selected and as data collection tools, teachers' observation notes and students' reflection papers were used. The objectives that might be coherent with interdisciplinary approach were selected and the collected data were analyzed both descriptively and contextually. The results revealed positive improvements such as developing different perspectives by getting to the problem source, better learning as a whole by making use of different disciplines and being well organized while presenting the outputs as well as transferring them into the daily life. Moreover, interdisciplinary education of geography course also contributed to gaining objectives and permanent learning.

Güneş and Taştan Akdağ (2015) conducted a research to find out how high school students feel about the energy topic, their abilities to relate and use information across disciplines, and to evaluate some of the elements that affect them. By using open-ended semi-structured questions, data from 20 boys and 20 girls, in total 40 high school students from the city of Samsun was collected and evaluated. It was observed that students' conceptual understanding, energy description and conversion, and interdisciplinary knowledge transfer were not at the desired level. Also, socioeconomic position, gender, parental educational status, sibling number, and whether a student is a boarder or a day student were not associated to research factors. As a result, it was suggesting to be useful to benefit from Physics, Chemistry and

Biology in an interdisciplinary setting for the teaching of energy topic at high school level.

Özay Köse, (2016) investigated the interdisciplinary cases and the difficulties associated with them in both national and international biology teaching programs. The results showed that the interdisciplinary teaching approach increased academic achievement, critical thinking, motivation and attitude by fostering communication with other disciplines and helping to find solution for daily life problems. The study also compares and evaluates international biology teaching programs with 11 biology teacher programs in Turkey. The results reveal that unlike international programs, the programs in Turkey do not offer interdisciplinary licenses and such applications are available only as elective courses with less hours.

Supporting an educational renewal due to changing world conditions and socio-cultural structure, Çelik (2017) aimed to identify the involvement of interdisciplinary associations in history classes by drawing upon teacher and student views. For this purpose, 168 students from 10th grade in Fatsa province participated in the questionnaire. The findings stressed that sociology was the most relevant and literature was the less relevant discipline to history. However, the overall interdisciplinary associations in history classes were found to be inadequate within the sample group.

Özaydınlı and Kılıç (2019) pointed out the secondary school mathematics, physics, chemistry, and biology teachers' perspectives on mathematics education as well as their classroom practices when using an interdisciplinary teaching style. With the participation of 70 teachers around Turkey, the data was collected by open-ended questionnaire by using content analysis and qualitative research methods. The study reveals that teachers have a conceptual understanding of interdisciplinary education and believe that it is useful in generating academic performance and positive attitudes in their pupils. Teachers think that rates-ratio is the most closely related issue in mathematics to all science courses; derivative is linked to physics, logarithm to chemistry, and probability to biology. Although the teachers bear favorable attitudes toward interdisciplinary education, most of them are unable to engage in interdisciplinary practices due to a lack of time and intensity in the curriculum.

According to the research, the teachers' inability to plan an interdisciplinary lesson can be attributed to a lack of understanding and implementation challenges.

2.10. Summary of Literature Review

With the advancement of technology and the ease of access to information, there is a transition from an industrial structure to a globalization, innovation and knowledge-based economic structure. The main purpose of education is to prepare students for this changing and developing real life, that is, not individuals who memorize information, but individuals who can adapt to change, learn how to access information, solve problems and are creative. This means that the education system should improve with this changing world and evolve to meet the needs. For this reason, interdisciplinary education, which provides the development of 21st century skills, prepares students for real life and eliminates the deficiencies of disciplinary approach in solving real life problems, has become important.

Interdisciplinary education can enable students to see the connections between disciplines better and to be more successful in solving a complex problem. Studies on brain and learning show that interdisciplinary education increases students' critical-thinking more than traditional methods and contributes to both their social and cognitive development.

The literature shows that interdisciplinary education, which is recommended by the Ministry of National Education, and about which the national and international studies are increasing and gaining importance day by day, is applied at a very low degree at high school level in our country. On the contrary, it is seen that teacher-centered practices are still widely used in classrooms. When the reasons that affect the applicability of interdisciplinary approaches in formal education are investigated, factors such as inter-curricular connections, teacher and student readiness levels, teachers' working tempo, standardized discipline education, lack of resources in public schools, crowded classrooms, etc. come to the forefront.

When researches on interdisciplinary education in Turkey and abroad are examined, it is possible to come across pilot interdisciplinary studies at every level. In domestic studies, interdisciplinary studies are carried out in a public school mostly in order to

assess the integration of different courses at different levels and they are interpreted by taking into account the student achievements and the application process.

CHAPTER 3

METHOD

This chapter presents information about the overall design of the study, research questions, data sources, data collection instruments, procedures, and analysis. In addition, issues of trustworthiness, limitations and the role of the researcher are provided.

3.1. Overall Design of the Study

The aim of this study is to research the practicability of interdisciplinary studies among science (biology, physics, chemistry) and mathematics at secondary schools. In this regard, it is aimed to examine the subtopics such as the required elements for the practicability of interdisciplinary methods according to teachers' views, the readiness of school, teachers and students for interdisciplinary studies, obstacles and limitations during the phases of planning-implementation-after implementation.

Once the instability and complexity of human factor is involved in social sciences, as different from natural sciences, the facts and information the results would direct us becomes more flexible rather than a strict and certain result (Berg & Lune, 2016). The significance of a qualitative research comes into the picture at this point. In a qualitative research, the situations are evaluated from the individuals' points of views and the focus is on fictions and meanings aimed at finding answers to "how" and "why" questions rather than numeric data or the answers to "what" questions (Robson & McCartan, 2015).

Since this study aims at interpreting the views of teachers about interdisciplinary studies by the perspective of the schools they are working at or by the curricula, it is designed as a qualitative research.

Due to the fact that there are many factors affecting the performance of an interdisciplinary study (school conditions, teacher and student factors, sufficiency of resources, suitability of the curriculum etc.), the study results are foreseen as addressing to a specific area rather than a generalization. Therefore, the design of the study is determined as case study.

In a case study, a situation regarding the factors such as situation, individuals, processes are researched as integrated; just like the impact of situation on the factors and the impact of factors on the situation (Yıldırım & Şimşek, 2005). The definition of situation in these factors, interpretation and, in the event that different factors were present, the comparison of new situation are among the goals of case study. According to Flyvbjerg (2006), the results obtained by the case study being inconvenient for generalization would not make the study worthless. On the contrary, in social sciences, some theories fall behind in explaining the phenomena related with people. Some essential goals such as the tests of discoveries of theories for a specific situation could be obtained by case study as well.

In qualitative studies, by the complicated structure of human, the best place to research the thoughts and behaviors should be the environment that they are displayed (Yıldırım & Şimşek, 2005). Thus, the place where the teachers' views and observations are made is the school environment where the feasibility of interdisciplinary studies are discussed.

The study was performed in a specific private school chosen a case to gather in-depth data regarding the feasibility of interdisciplinary studies. The rationale behind utilizing case studies as a research design in this thesis can be justified with the following arguments; (1) it is appropriate to use the case study method specifically for collecting comprehensive information about the apprehensions of the participants, and (2) when social units such as individuals, groups or institutions are considered, it is an optimal methodology to conduct a detailed and holistic study (Baxter & Jack, 2008; Feagin, Orum, and Sjoberg, 1991; Yin, 2009).

Case studies can be examined under different groups. According to Yin (1984), case studies can be analyzed in three groups: exploratory, descriptive, and explanatory. This study falls into exploratory case study group for the reasons that it investigates the

feasibility of interdisciplinary studies at a specific school and examines the factors behind the outcomes. Exploratory case study primarily aims for exploring the phenomenon. At the same time, the researchers' creating the research with small unstructured observations prior to exploratory study also could become a part of this research pattern (Yin, 1984). In this research, the researcher first observed the school that she was working and made use of these observations in the phases of research questions creation and hypothesis setup.

The participants of the study were selected by purposeful sampling. Firstly, only four disciplines are selected to examine the feasibility of interdisciplinary studies: physics, chemistry, biology and mathematics (numeric fields). The purpose of selecting teachers from these fields is for enabling the interdisciplinary connections at the maximum levels. Natural sciences (physics, chemistry and biology) can create common disciplinary fields other than their own disciplinary studies such as biochemistry and biophysics, and mathematics is regarded as the language of these sciences. Interviews were held with two teachers from each selected discipline (i.e. physics, chemistry and biology) as well as the heads of the departments, who also had an administrative role. For mathematics discipline, the interviews were made with three teachers and the department head since they are having relatively more teachers than the other departments.

Qualitative data was collected through semi-structured interviews with head of the departments and teachers. Additionally, during the data collection process, unstructured observations were made and the implementation of the program was examined. In addition, the curriculum was examined and content analysis was made, and the project documents of the departments were examined in terms of the feasibility of interdisciplinary studies.

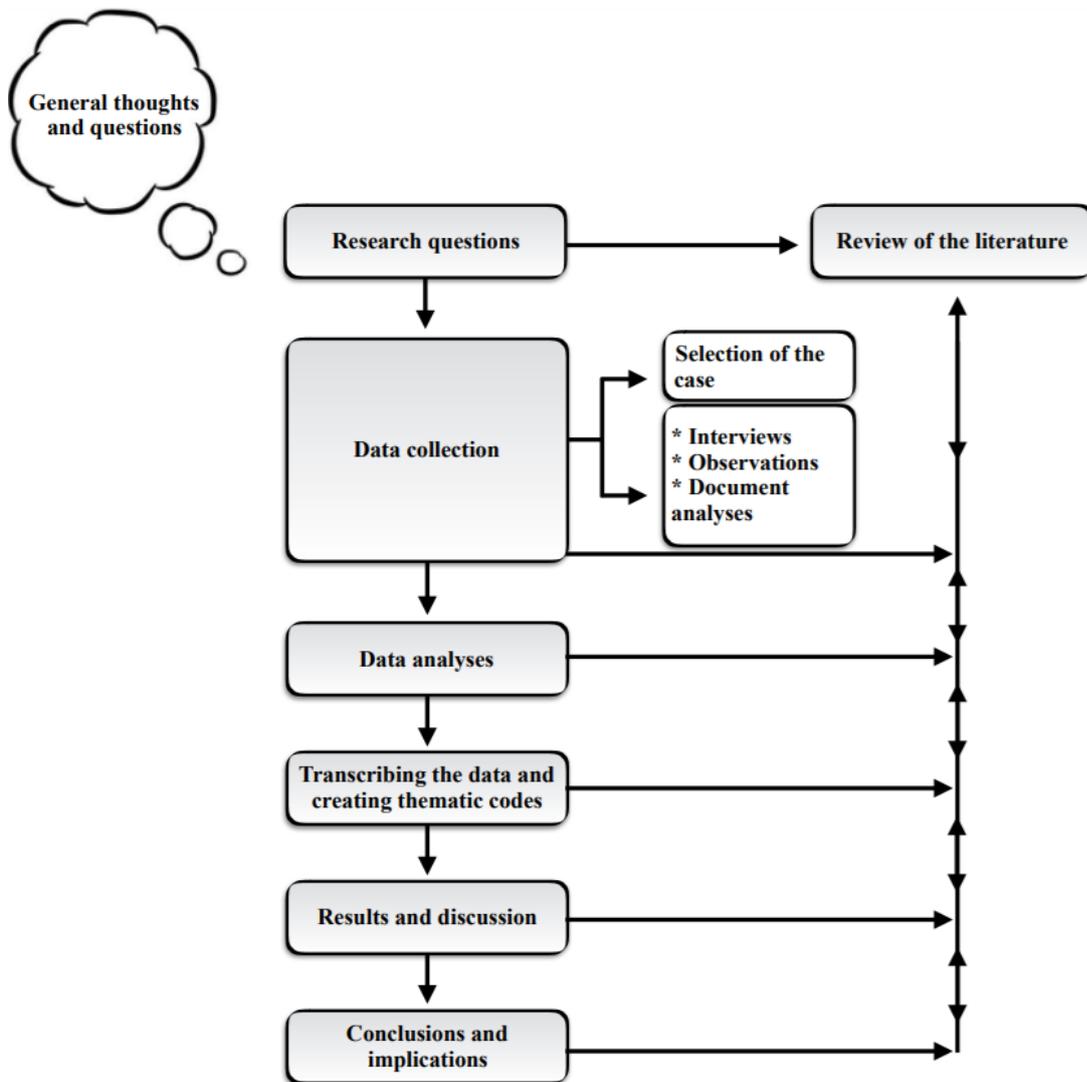


Figure 3.1 The General Flowchart of the Research Design (Adapted from Taneri, 2010)

3.2. Research Questions

This research aims to answer the following research questions:

1. What is the applicability of interdisciplinary approach in high school science and Math education?
2. Which factors affect the implementation of interdisciplinary approach in high school science and Math education from the perspectives of science and Math teachers in terms of its requirements, benefits and restrictions?
3. What are the opinions of science and Math teachers about teacher education of interdisciplinary approach?

3.3. Data Sources

Four types of data source were consulted for the present study. The first data source was people: teachers and department heads (participants); the second data source for this study is place: MASELSA School (the case); the third data source for this study is things, events, artifacts of Science and Mathematics departments, and the fourth data source for this study is documents related to science and mathematics curricula.

In this study, document analysis, semi-structured interviews with science and mathematics teachers, observations of science and mathematics lessons and school culture were used as data collection tools.

According to R. Stake (1995), in a case study the information sources that the researcher should use can be listed as bullet points for checklist purposes. By this way, the data collected in the study could be seen in a more holistic frame. The general representation of the sources used in this study is given in Table 3.1.

Table 3.1 Information Sources Used in Case Study Research

<i>Information Source</i>	<i>Interior</i>
People	Science and Math Teachers (including Science and Math Department Heads)
Places	School
Documents	Biology, Physics, Chemistry and Math MoNE Curricula and Artifacts of departments (evaluation documents, project documents etc.)
Events	Science and Mathematics Lessons, teachers board meetings, field trips, festivals, fair, project days, certain days and weeks celebration etc.

Adapted from Hancock (2006)

3.3.1. Participants

For this research, science (biology, physics, chemistry) and mathematics departments of MASELSA School are selected. There are five teachers in each of the physics, chemistry and biology departments. However, since one teacher from each department teaches only 12th grade students with problem-solving-based teaching methods focused on preparation for the university entrance exam, these teachers were excluded from the sample. In addition, since one teacher from each department was interviewed for the pilot study, these teachers were also excluded from the study. For this reason, semi-structured interviews were conducted with two teachers and a department head from each department in the field of science.

Similarly, out of a total of nine mathematics teachers, two teachers who teaches only 12th grade students and one teacher who participated in the pilot study were excluded from the study. Semi-structured interviews were conducted with three teachers and a department head, who were selected on a voluntary bases among the remaining six mathematics teachers.

The participants are requested to answer the questions about demographic information such as age, department of graduation, work experience etc. The average age of the participants is 38. Of the 13 participants, 9 have a master's degree and the average tenure is 14.

The teachers were given pseudonyms; Zehra, Feryal, Esin, Elif, Samet, Mert, Hasan Sevgi, Eren, Bilgi, Gülay, Fatma and Ahmet.

Since qualitative and quantitative studies are based on different philosophical and notional elements, their sample selections differ as well. Unlike quantitative analysis, there is no need for a large set of samples in qualitative analysis because the goal is not to generalize a theory or a concept (Yıldırım & Şimşek, 2005). Whether the methodology used is quantitative or qualitative, sampling methods aim to maximize efficiency and validity (Morse & Niehaus, 2009).

For case studies, a method widely preferred in qualitative studies, the situation already exists within the case and this would enable sampling to be selected wholly or partially among the individuals experiencing that situation. Sometimes only one person could

become the sample in case studies, sometimes it may become necessary to have a larger sampling. The variability in sample number can be observed even while collecting study data according to convenience of hypothesis and research questions due to the flexible nature of qualitative research (Marshall, 1996). In this study, criterion sampling, which is one of the purposeful sampling strategies, was used to select participants who have the most pertinent and valuable information. Purposeful sampling allows the situations that are assessed to have rich information to work more in-depth and detailed (Patton, 1987). Strong relationships between natural sciences and mathematics form the basis for interdisciplinary studies (Park-Rogers, Volkmann, & Abell, 2007; Manolea, 2014). Therefore, the participants of this study were determined according to the branch criteria, that is, sciences and mathematics teachers who were compatible with interdisciplinary studies were selected as participants. In this regard, thirteen experienced teachers specializing in mathematics, chemistry, biology and physics were selected for this research.

As mentioned before, during the pilot interviews, it was revealed that the science and mathematics teachers who teach only 12th grade students see the 12th grade as preparation for the university entrance exam, so they focus on exam success, and cannot spare time for interdisciplinary studies. As a result, it was supposed that these teachers could not contribute to the collection of data that would provide in-depth information about the subject of the study, and therefore these teachers were excluded from the sample.

In a case study, a sample is also important in terms of data saturation, theoretical saturation and reaching informal redundancy (Fush & Ness, 2015). In the study data collection, when the data collected from various participants start to repeat itself, when the researcher cannot access different information any further, it can be said that the sample size required for this study has been reached (Galcer & Strauss, 1967). For this study, the sample is selected as the whole science and math departments except the teachers of 12th graders. However, since the participation to the study is on voluntary basis, two teachers from mathematics department who did not want to participate are removed from the sample. During data collection, theoretical saturation was observed by the researcher in the coding phase of data analysis.

3.3.2. The case

This study was conducted in the high school called MASELSA School (pseudonym), where the researcher was working as a Physics teacher. MASELSA school, located in a central region of Ankara, was established in 1989 as a primary and middle school. After the first students graduated from middle school, the high school department was established in 1994. Since then, emphasis has been placed on raising students who embrace the school culture, from primary to middle school and from middle school to high school.

The mission of the school is described as “becoming a distinctive school with proven international recognition” and its vision is stated as “raising the students as individuals who internalize Kemalist ideology and who are equipped with the knowledge, skills and values that modern life requires, in environments where individual development is deemed important and the opportunities of self-fulfillment are provided”. In the philosophy of the institution, it is mentioned that every individual is a world citizen. The school follows up global educational advances closely and values the highest benefit of students in all of its implementations. There is a commitment to offer a safe school environment with mutual respect to people and cultures. Furthermore, in addition to academic upskilling, the school introduces a comprehensive, rich, and flexible education and training program that supports social, emotional and physical abilities and satisfies interests, needs and expectations.

Literature reveals that new technologies and emerging pedagogical practices create new requirements for educational buildings. Students' performance increases in schools with better physical learning environments (Barrett, Treves, Shmis, Ambasz & Ustinova, 2019). Therefore, based on the assumption that learning environments that both create better spaces for students and invest more in educational infrastructure are more suitable for conducting interdisciplinary studies, data were collected from a private school instead of a public school in this study.

The high school department, which was in the same building as the middle school when it was first established, moved to a new building with the transition to project-based and student-centered education with the increase in the school population. The new high school was built as a brighter building with glass rather than a wall, including

many laboratories and workshops. This two-fold building contains four physics laboratories, four chemistry laboratories, four biology laboratories, one meeting room, one dining hall, one painting studio, one music room, two-folded library including silent study room and a computer laboratory. Although the high school consists of one single building, it has sectional operations. When the building is considered as two sections, right wing and left wing; on the right wing, only science laboratories, dining hall and workshops are located, on the left wing, there are separate sections for four grades (9th graders with also prep classes, 10th, 11th and 12th graders). At the sections of each grade, there are rooms of the deputy manager, psychological counsellor and advisory teacher of that grade level. There are 12 classrooms at each section, adding up to 48 classrooms in total, with an average size of 18 students.

In addition to deputy manager, psychological counsellor and advisory teacher of each grade, there are 84 teachers at the high school section. There is no single room where teachers can get together or use collectively. Each discipline has a room assigned that could be located in anywhere within the building. For physics, chemistry and biology, the rooms are placed in proximity of the laboratories. Each physics, chemistry and biology teacher (except teachers lecturing 12th graders) has his/her own laboratory where students attend their respective classes. The students use the workshops and gym for multiple purposes, for example painting, music or physical education classes. For the other courses, they have their fixed classrooms where teachers of the remaining courses teach at.

Preparatory, 9th and 10th grades take 8 hours of lessons every day, 4 in the morning and 4 in the afternoon, with a lunch break in between. 11th graders also have 8 hours a day, 12th graders have 9 hours of classes, and these two groups have 5 hours of classes in the morning. This situation makes the timing of lunch breaks different from each other according to grade levels. Therefore, teachers' lunch break also varies depending on the level of class they teach.

It is compulsory to wear a school uniform every weekday except Wednesday. Wednesdays are casual dress days and during the last 20 minutes of 7th hour, the students meet their classroom teacher. These meetings are followed by an hour of club events at the 8th hour. Students select their clubs in line with their interests at the

beginning of the year. Some examples of these clubs are Kemalist Thought and its History, Cultural World Heritage, Future Problem Solving (FPS), Entrepreneurship, Model United Nations (MUN), Robotics, Environment, Painting, Culinary, 3D painter, Dance, Theatre, Cinema, Visual Arts, Philosophy, Destination Imagination (DI), Chess.

The school implements the MoNE curriculum in English. For this reason, textbooks of physics, chemistry, biology and mathematics courses provided by the Ministry of National Education are distributed as an additional resource at the beginning of the academic year. However, neither MEB books nor other Turkish books are used as sources in the content of these courses.

Physics, chemistry and biology departments prepare their own English textbooks as well as exam questions and other assessment tools.

Nonetheless, since students will take the national university entrance exam at the end of 12th grade, in addition to English sources, Turkish exam questions and similar evaluation tools are also prepared. By means of the agreement made with Cambridge International Education, the biology department uses Cambridge Press biology textbooks and benefits from the exam questions and other evaluation sources published by Cambridge Press.

3.3.3. Documents

To examine the interdisciplinary suitability of science and mathematics courses, MoNE curricula are analyzed. The similarity between curricula at all grades are reviewed and the emphasizes that the Ministry of National Education made regarding the interdisciplinary studies in the curricula are investigated. At the same time the evaluation exams, worksheets as well as the project documents and laboratory reports that the departments made for students are scrutinized.

3.4. Data Collection Instruments and Procedures

In a qualitative research, it is preferred to use more than one methods for researching and explaining research questions in a clear and detailed way (Yıldırım & Şimşek, 2005). Triangulation is the method of analyzing data by utilizing several data sources

or approaches to boost the credibility of a study (Salkind, 2010). According to Denzin (1978), a study can be strengthened with triangulation in four ways: (1) data triangulation – using the method of collecting more than one different data in the study (2) investigator triangulation – more than one researcher taking place in the study (3) theory triangulation – interpreting the data in the study with more than one theory or perspective (4) methodological triangulation – using more than one different methods in solving a problem. This study is strengthened with data triangulation. Data are collected in three different methods; semi-structured interview, unstructured observation and document analysis.

3.4.1. Semi-structured interviews

According to Patton (2015), there are two different approaches in a study: one point in time versus longitudinal inquiry. With one point in time approach, this study is designed to have the teacher interviews only once. Since it is aimed to extract the required data in one below with this approach, a larger sample size is engaged and semi-structured interviews are conducted with all the science and math teachers accepting to participate excluding the teachers of 12th graders. Nevertheless, the data obtained by researcher through observation is extended over a longer period of time. This enables researcher to track evolve, emerge and unfold of the phenomenon throughout the process.

A semi-structured interview form consisting of seventeen open-ended questions, four of which was about demographic information, was used in the study. While designing the interview, a pilot study was conducted before collecting data and expert opinions were obtained from an academician in the department of curriculum and instruction and an expert who holds a PhD on the topic of assessment and evaluation.

Prior to the interview, the teachers are informed about the study and asked for their permissions to record the conversation. The teachers' points of views about the factors for performing interdisciplinary studies, their benefits to teachers and students, the difficulties along the planning and implementation stages are generally discussed during the interviews. The interviews lasted 25 minutes on average.

The interview questions are reviewed by two experts and a pilot study is performed with one teacher from each of mathematics, physics, chemistry and biology departments. The questions that lead to understanding differences are corrected and sub-questions are generated by the researcher for those questions that have limited answers. Before the interview, an informative e-mail was sent to the teachers by the researcher and they were informed that the interviews will be recorded. Thus, their permissions are granted. The interviews with physics, chemistry and biology teachers are conducted at the laboratories belonging to the teachers. Whereas, for the interviews with mathematics teachers, the meeting room of the school is used. In the Table 3.2, the dates and lengths of the pilot studies are provided.

Table 3.2 The Date and Length of the Pilot Studies

<i>Participants</i>	<i>Date</i>	<i>Length</i>
Math Teacher	7 March 2019	15 min
Physics Teacher	8 March 2019	14 min
Chemistry Teacher	8 March 2019	25 min
Biology Teacher	9 March 2019	14 min

In the Table 3.3 , the dates and lengths of the interviews conducted with the teachers are provided. The participants are remarked with the generated codes in the table.

Table 3.3 The Date and Length of the Interviews

<i>Participants</i>	<i>Date</i>	<i>Length</i>
Zehra	28 June 2019	24 min
Feryal	28 June 2019	25 min
Esin	29 June 2019	31 min
Elif	29 June 2019	30 min
Samet	29 June 2019	20 min
Mert	1 July 2019	75 min
Hasan	27 June 2019	15 min
Sevgi	27 June 2019	20 min
Eren	27 June 2019	14 min
Bilgi	28 June 2019	18 min
Gülay	26 June 2019	28 min
Fatma	26 June 2019	18 min
Ahmet	25 June 2019	17 min

3.4.2. Informal observations

In a qualitative research, together with the other data collection tools, the researcher can use the observation in order to obtain a holistic data by evaluating the behavior developed in an environment or an institution in a more comprehensive way spreading over time (Patton, 2015). In this research, informal observation methodology is employed. The researcher of the study has been working at MASELSA School's physics department actively for five years. For this reason, the researcher uses participant-observer method and researcher-observer method for the purpose of defining school culture and values as well as written and unwritten rules. School's culture, school's approach to teaching and learning, communication between departments, communication within departments, teacher-manager relationship, teacher-parent relationship, management-parent relationship and teacher-student relationship are observed. Moreover, the climate at science and math classes, as well as the instructional methods and materials used at these classes are also observed by the researcher.

3.4.3. Document analysis

For the present study, a document analysis was utilized in order to examine the aspects of interdisciplinary studies. The documents including science and math curriculum, exam papers, textbooks, and lesson plans were analyzed in terms of process, approach, models used, and decisions taken in the curriculum.

During the thesis process, primarily physics, chemistry, biology and mathematics MoNE curricula are examined. In alignment with this examination, the suitability of curricula for interdisciplinary studies along with the gains in the curricula and desired skills to be brought in to students are investigated. The evaluation tools that are used by the departments are requested and examined together with the assessment and evaluation methods. Upon completion of interviews, in line with the data collected from the teacher, it is found necessary to analyze ICGSE (International General Certificate of Secondary Education) and IB DP (International Baccalaureate Diploma Programme) curricula other than MoNE curricula.

3.5. Data Analysis

In qualitative research, the data analyzes are observed to be various, flexible and creative. Every researcher may need to develop a data analysis plan for his/her research. The literature shows that a single strict data analysis cannot be mentioned in qualitative research, a formula is developed for data analysis. There is a guide for analysis but there is no to-do-list word by word (Patton, 2015). According to Strauss (1987), by the form of qualitative research, data analysis should not be standardized, this approach is against the nature of research however the analysis process should also be comprehensive and systematic. For this reason, many researchers have generated guides for data analysis in qualitative research. If the common points of these guides are examined, they all emphasize three basic concepts in a qualitative research analysis; description, analysis and interpretation (Yıldırım & Şimşek, 2005).

In the description part, what types of results the data collected in the research reveal regarding the problems of the research are considered. For example, the points raised in the interview or remarked in document analysis, the observation findings related to the research questions etc.

In the analysis part, the conceptual codes as well as the themes and the relationships between themes are discovered in interview, observation or document analysis. According to Miles & Huberman (1994), these codes and themes should be tabulated or plotted, in other words they should be visualized. Their relationship among each other should be emphasized and interpreted.

In the interpretation part, the meanings of expressions in the interviews or the observed phenomena are interpreted and the researcher can reflect his/her points of view in this section. These interpretations may not be expected to be generalized or to be accepted by all others.

3.5.1. Transcribing the data

Firstly, all audio data from the interviews were transcribed. While making transcription the indicators such as voice tone, pauses or laughter are taken into account. After completion of transcription, while listening to the audios, next to the transcriptions, the researcher noted down the interpretations that could be extracted

from the sentences and generated themes appropriate to these interpretations. While creating codes, interpreting and reporting interviews, for the readers, specific abbreviations are assigned to each participant. These abbreviations can indicate whether the interviewee is the head of department or not. They can also specify the department of the interviewee. For example, for the interview performed with mathematics teacher Zehra: "MI Zehra".

Table 3.4 Classification of Quotes

Abbreviation	Definition
MI	Math Teacher Interview
PI	Physics Teacher Interview
CI	Chemistry Teacher Interview
BI	Biology Teacher Interview
DHI	Department Head Interview
O	Observation
DOC	Written documents such as MoNE Curricula, teacher worksheets etc.

3.5.2. Coding the data

According to Thomas (2006), in an inductive analysis, firstly raw data are examined carefully and specific themes are extracted out of these data by coding. After coding, in the phase of theme extraction, five basic features are significant: (1) category label: the general meaning that the theme carries is expressed with one word or phrase; (2) category description: the researcher identifies the meaning of this category, its characteristics and boundaries; (3) text or data associated with the category: within the data, the examples that carry the meaning of this category are accommodated; (4) links: the links between the categories are determined, these links could be in parallel or hierarchical order; (5) the type of model in which the category is embedded: the relationship between the categories and a specific model, framework or theory but sometimes categories may not be correlated with a specific theory.

Creswell (2002) summarizes the coding process in an inductive analysis by five stages:

- Conducting data reading,

- Identifying specific text segments related to objectives,
- Labeling the segments of text to create categories,
- Reducing overlap and redundancy among the categories
- Creating a model incorporating most important categories

Coding consistency check has three stages: independent parallel coding, check on the clarify of categories and stakeholder or member checks (Thomas, 2006).

In this research, the transcription of interview data is primarily done by the researched. Then, these transcripts were coded by the researcher and another person who is a graduate student at the curriculum and instruction department like the researcher. After comparing the similarities of two different researchers' codes from the same raw data, a recheck was conducted by transferring the main researchers' codes and categories to second researcher. At the same time, together with the extraction of codes upon completing interview transcriptions, these codes with transcriptions were shared with related participants and they were asked whether these outcomes reflect what they meant in the interview.

By this way, this process is iterated by the researcher until the themes are finalized and linked with the research questions.

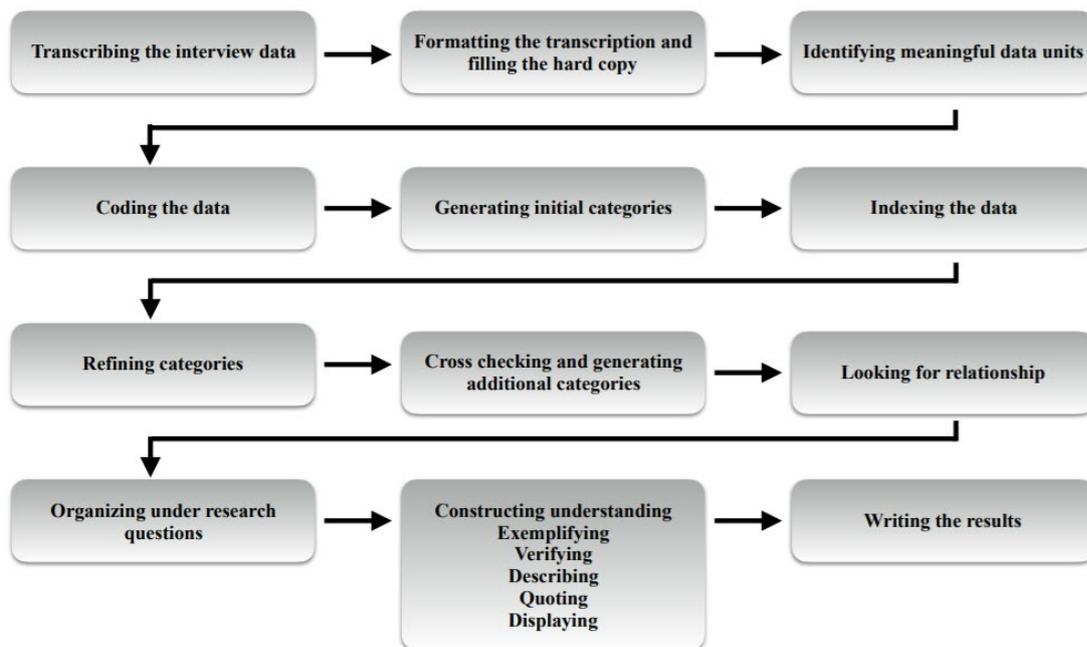


Figure 3.2 The General Data Analyses Steps (Adapted from Collins, 1999)

3.5.3. Presentation of the results

The research outcomes are presented in a way to support research questions in the frame of unstructured observations, semi-structured interviews whose codes are finalized and themes are generated and document analysis. The themes generated by coding and the subsections of these themes created the categories at the result section. Since the themes and the links between them are the main findings of the study, they are supported with the direct quotations of the participants from the interviews. At the same time, the observation outcomes and interpretations of the researcher are accommodated at the result section since the researcher is also a teacher of the school and a participant observer of the research.

3.6. Trustworthiness

Validity and reliability are the two most important criteria for the credibility of the researches. In a qualitative research, a statistical test cannot be applied for the measurement of these concepts, but instead, the researcher is expected to highlight the nature of the researched situation by properly planning, explaining the situation, collecting, analyzing, describing and presenting the data in a valid and supportive way (Yıldırım & Şimşek, 2005; Patton, 2015). In this context, while validity in a qualitative research generally describes the accuracy of the research results and the researcher's impartial observation (LeCompte & Goetz, 1982), reliability is defined as replicability, but since the results of qualitative research naturally depend on the people and the environment they are in, and since these may change, reliability is handled differently in qualitative research than in quantitative research. (Yıldırım & Şimşek, 2005).

3.6.1. Internal validity and external validity

According to Miles and Huberman (1994), the findings obtained in the research should be gained by using different data sources and different data collection methods in order to ensure internal validity. In this study, it was desired to draw a more comprehensive picture on the research topic using triangulation. For this reason, semi-structured interviews were made with the teachers, the documents were analyzed and the teachers were observed in their working environments. The semi-structured interview was prepared with open-ended questions, so the participants expressed themselves more

freely and the researcher avoided directing the participants during the interview. Interview questions have been evaluated by both experts in the field of curriculum and instruction and by experts in the field of measurement and evaluation. Also, a pilot study has been carried out in order to avoid any misunderstanding. Recording the interviews also enabled the researcher to describe the emotions of the participants while transcribing the interviews.

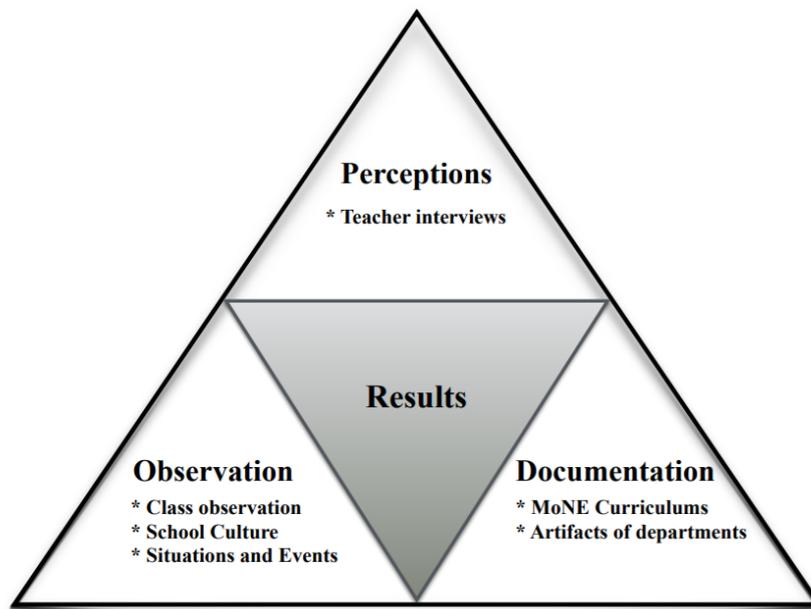


Figure 3.3 Triangulation of the Data (Adapted from Carugi, 2014 as Cited in Institute of Medicine, 2014)

In ensuring internal validity, it is important that the findings are considered realistic by the participants (Miles & Huberman, 1994). For this reason, after the interviews were transcribed and the coding was completed, two participants were shown their interviews again in order to question the compatibility of the findings with what they wanted to express and to receive their feedback.

External validity is related to the generalizability of research results; however, in qualitative studies, it is not possible to directly generalize with other research results due to the assumption that social events change according to the environment (Yıldırım & Şimşek, 2005). Only a certain level of generalization is possible, and for this generalization, the process and the environment in which it is studied should be well

described in order for qualitative research to be at a level to be compared with other researches (Miles & Huberman, 2009 as cited in Yıldırım & Şimşek, 2005). In this study, demographic information of the participants, the school they work at (the case), as well as the place and stance of the researcher in the data collection process were described in detail.

3.6.2. Internal reliability and external reliability

The basic features of qualitative research may conflict with the requirements of external reliability. Since it is not a numerical data and it cannot be interpreted statistically, each researcher might interpret qualitative research findings differently and therefore the exact replicability of the research can be questioned (Yıldırım & Şimşek, 2005; Leung, 2015). In qualitative research, if the position of the researcher and the participants are well defined, it can be ensured the researchers working similarly can take similar roles. For this reason, although this research is not exactly the same, what has been done on research methods, data sources, data analysis processes and reaching results are described in detail so that it can lead to similar studies.

In order to ensure the internal reliability of this research, first of all, another researcher was included in the analysis of the data and crosschecked. The compatibility of the research results with the data and research questions was checked. In the data analysis, biases and misunderstandings were paid attention and data that were standing out of the research scope were removed. The research findings were associated with the literature and attention was paid to the criterion of consistency.

3.7. Ethical Issues

In this study, firstly, permission was obtained from the school where the study was to be conducted. Upon the readiness of data collection instrument, the interview questions were presented to the university's ethics committee and permission was obtained to interview the participants on the grounds that they would not get any physical or psychological harm. During the data collection process, a written text describing the aims of the study and the data collection process was presented to the participants, information was given about the confidentiality of the data, and additional

questions or concerns from the participants were verbally answered. Permission was obtained from the participants in order to record the data during the collection process.

3.8. Limitations

The findings of this study have to be seen in light of some limitations. The first limitation of this study originates from the nature of qualitative research. Since this study was designed as a case study set in a private school, the results cannot be directly generalized to other private and public schools. Even the context, culture and structure of the school chosen can affect the results of the study, but the results can also provide a perspective for other schools of similar nature.

The second limitation of the study is that the data are based solely on the opinions of teachers working in natural sciences and mathematics at one private school (MASELSA). For this reason, the results of the study are limited only at the level of teachers' perceptions and knowledge about interdisciplinary education.

Another limitation is that the researcher has been working as a teacher at MASELSA school for 5 years. Although this situation could contribute positively to the research in terms of getting to know the school better, it may create a limitation in the interview results due to the fact that she knows the participants. However, the researcher assumes that the teachers conveyed their real thoughts during the interviews in a reliable and sincere way.

3.9. Role of the Teacher

In a qualitative research, the background of the researcher and its associated role in the study should be properly defined. In this study, the researcher graduated from secondary school teaching physics department in 2014. After graduating, she completed the Human Resources Development in Education non-thesis master's program in 2016. At the same time, she started to work in MASELSA schools and since then she has been actively working as a physics teacher in MASELSA's secondary school for 5 years. She preferred to do her second master's degree in the field of curriculum and instruction in order to be able to perceive and analyze curricula from a wider perspective and to be more knowledgeable about teaching and learning processes. With the courses she took in her master's degree, the importance of student-

centered education and the development of 21st century skills attracted the attention of the researcher, and she started to notice the deficiencies in education and training in this field at the school where she has been working. As the Turkish education system could not achieve the desired success in international education evaluation results such as PISA, etc., she researched the education systems of the countries that achieved success and she realized the importance of interdisciplinary education in preparing students for today's world. Although our national education system also emphasizes interdisciplinary studies, researcher's curiosity about why these applications were not used effectively in MASELSA school has increased significantly.

In this study that was designed as a case study by the researcher, the researcher tried to avoid the situation of manipulating the thoughts of the participants, since the main data collection tool was interview and the researcher was familiar with the participants, and she tried to ensure that the teachers focus on the main topic in order not to get out of the course of the study.

In this study, the researcher is definitely not inclined to judge the institution or people that she works together. The aim of the study is to investigate and interpret the usability of interdisciplinary practices in teaching and learning processes from the perspective of teachers.

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CHAPTER 4

FINDINGS

In this section, data results collected from observations, document analysis and teacher interviews are presented. The goal of the study is understanding what teachers need and what path they would like to follow while designing interdisciplinary studies, investigating the benefits of this study and the reasons behind the disability to perform these studies or understanding the difficulties faced while performing. Lastly, whether teachers need a training on this subject and in case of the need, the design content of the training are examined.

In line with the research question and data analyses, the results are presented under five categories:

- Applicability of interdisciplinary studies
- Requirements of interdisciplinary studies
- Benefits of interdisciplinary studies
- Restrictions
- Education or training of teachers.

4.1. Applicability of Interdisciplinary Studies

With the first research question posed as “What is the applicability of interdisciplinary approach in high school science and Math education?” it is aimed to reveal the applicability of interdisciplinary studies in high schools. Document analysis , teacher interviews and in-school observations reveal that high school level interdisciplinary studies among mathematics and science groups do not take place in MASELSA school. In this context, both curricula of disciplines and sample project documents are requested from the departments and examined. When the MoNE curricula of mathematics, physics, chemistry and biology are analyzed, it is observed that the goals, values, competencies, assessment and evaluation approaches of all curricula are constituted jointly. The students are expected to gain specific skills that they will need

in their personal, social, academic and professional lives at both national and international levels. Some of these gains are mathematical, scientific and technological; some of them are taking initiatives, entrepreneurship and learning to learn, skills that help them adapt to the diversifying community life and become successful, identify the problems they will face throughout their lives and have the desire and capabilities to access the presence of knowledge towards explaining the natural life for the purpose of generating results based on evidences and benefit from the methodology (MoNE, 2018). While bringing these competencies, it is important to pursue non-standardized, flexible assessment and evaluation approaches that takes individual differences into consideration. According to MoNE, assessment and evaluation tools should be designed in a way to consider not only the results but the changes in the process and therefore, along with the student, active participation of teacher plays an integral role as well. At the same time, education needs to be provided not only for “knowing” that is thinking but also for “feeling” (emotion) and “doing” (action). Accordingly, assessment and evaluation application that only measures the cognitive abilities should not be utilized (MoNE, 2018). The different fragments among the curricula of physics, chemistry, biology and mathematics are the fundamental philosophy of these curricula and the implementation principals emerging from their general purposes. Within the points to take into account during the implementations of curricula, the interdisciplinary approach between mathematics and physics is emphasized whereas no direct emphasis was observed for the chemistry and biology curricula:

It should not be forgotten that preparing the teaching material and attending the classes well-preparedly are among the fundamental duties of teachers. While bringing students in the knowledge, ability, value and attitude related to physics course, teachers should not adhere to the textbooks only. The teaching materials should be structured and used in consistency with the factors such as the level of class, the interest and preparedness of students and their learning styles. Group teachers and teachers of other disciplines should collaborate in preparation of teaching materials. (MoNE Physics Curriculum, 2018, p. 12)

Collaboration with branch teacher such as mathematics, chemistry, biology, music and arts should be made for related gains. (MoNE Physics Curriculum, 2018, p. 12).

While preparing teaching materials, collaboration should be made with group teacher and teachers from other disciplines. (MoNE Mathematics Curriculum, 2018, p. 12).

STEM education is an interdisciplinary approach that helps students see the things they learned at science, technology, engineering and mathematics courses as a whole. As indicated in STEM Education Report of MoNE (2016), it is found necessary to implement STEM education in Turkey like many countries leading good practices in education do; accordingly, an action plan of 5 clauses is prepared and launched forth:

1. Establishing STEM education centers,
2. Conducting STEM education researches at these centers in cooperation with universities,
3. Raising teachers in a way to adopt STEM education approach,
4. Updating teaching programs in a way to include STEM education,
5. Creating teaching settings for STEM education at schools and providing course materials.

When the motivations for creating action plan are considered, it is also observed in this report that interdisciplinary applications in science and mathematics are not at sufficient level at schools, the preparedness level of teachers are low, education is needed, arrangements should be made in a way to give importance to such applications in curricula and to enable performing them.

Although there is an emphasis to interdisciplinary studies in the MoNE curricula that are implemented by MASELSA school, no teaching material prepared with participation of more than one disciplines are encountered during the analysis of group documents.

Classroom observations show that the interdisciplinary connections are underlined during the classes. For example, the pressure subject in physics is explained with examples from biology subjects, while teaching Mendel's Law in biology combination in mathematics is utilized by providing elementary level examples regarding the connection between two subjects, enabling students to reach their own deduction by making in-depth research on a project about these relationships.

4.2. Requirements of Interdisciplinary Studies

The second research question, "Which factors affect the application of the interdisciplinary approach in high school science and mathematics education in terms

of science and mathematics teachers?" aims to examine the experiences of teachers regarding the application of interdisciplinary studies at school. Teachers conveyed their own views and experiences on what needs to be done in order to carry out interdisciplinary studies in terms of its requirements.

According to the content analysis results, there came up six themes with 23 codes within the themes have been reached in the coding of the teacher interviews related to the requirements of interdisciplinary studies. Interview results show that for an interdisciplinary study to be conducted and worked in curriculum many factors play important role; such as school culture, content, environment for implementation, student readiness and the teacher.

The general state of interdisciplinary requirements is illustrated in Figure 4.1.

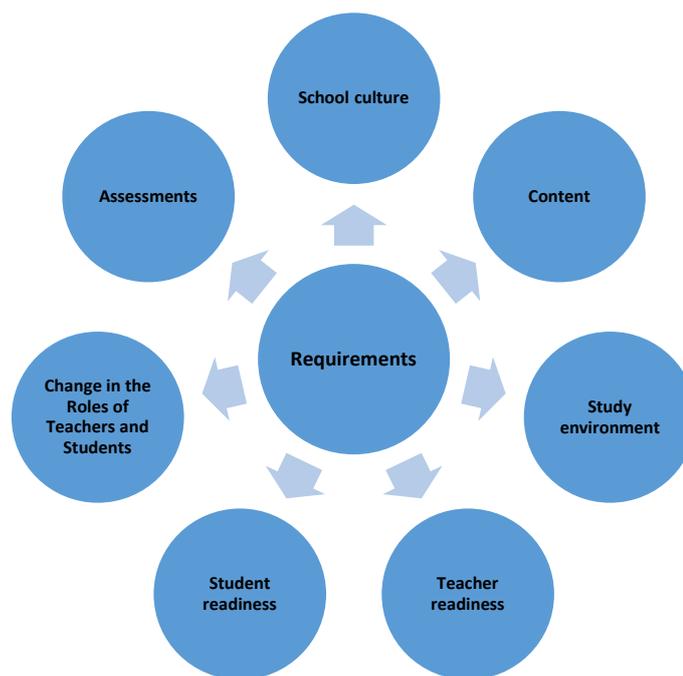


Figure 4.1 Requirements of Interdisciplinary Studies

4.2.1. School culture

Teachers emphasize that school culture is a critical element for an interdisciplinary study to be exercised. If a school possesses a test-dominant culture by imposing

students to only solve tests for university entrance exam and gaining a reputation around their success in that exam, interdisciplinary studies could be seen unnecessary, even waste of time. In this scenario, firstly, the school administration would object such projects and education programs. The students and parents who are aware of this culture would then stand against in solidarity with the school management. Eventually, the teachers would also tend not to embrace the interdisciplinary approach and prefer to stay within the boundaries of disciplinary education. As one of the teachers expresses in the interview:

Whichever product you would like to sell, you can find both sellers and buyers.
(Eren, CI)

This sentence summarizes that each school adopts an educational style, develops a reputation based on this style and attracts the parents who are willing to have their children taught in this style.

Teachers highlight that as requirements of interdisciplinary education; flexible and innovative management, interactive departments, school culture valuing learning process as well as the result and capable of reflecting managerial flexibility and innovation into the curriculum are of essence.

In teachers' views, it is stated as:

Some big schools even have curriculum development departments. I think we have deficiencies in this subject, as you remember, for couple of times we had trainings from outside about increasing the utilization of differentiated education applications at the school, they were left incomplete, the trainer was not approved. We had such an attempt once more, I think you were not at the school in those times, they could not make it again, that culture somehow was not established. With eagerness, the trials are there to do something, the start is given but the rest does not come along. The school does not have a continuity in that issue. (Hasan, PI)

Another teacher explains the indecision of management, its reflection on school culture as teachers as below:

Of course, the school culture is a very important factor in interdisciplinary applications. If it was the case for us, school management, even high management would lean towards but later on, if I were late in curriculum due to the project, it would directly be reported, I would even get a warning since I was not able to catch up. Then, the student who does the project would come

to me, he would be happy in the beginning but later on, he would observe that he is not able to allocate time for test solving while all of his friends solve tests. Then he would become unhappy, he would even complain to the management about me, the parents also would interfere (laughing). In summary, I would like to say dreams vs. realities. However, as I know, the coordinators try to implement this at secondary schools and it works, our coordinators do not even visit high school building, because I think here has a different culture from the rest of the school, there is no next after the high school, that is the secondary school students have the right to continue with us even if they perform well at high school entrance exam or not. Nevertheless, there is no after if they perform well at university entrance exam and I think it is perceived as the whole school, I mean the all levels of the school do not perform well. For example, if we were unsuccessful, the parents would see that the rating of this school at university entrance exam is not good and they back off from registering their 6-year-old child to the kindergarten of our school. (Sevgi, CI)

4.2.2. Content

For an interdisciplinary project or program to be designed, its content, its level and the applicable class' level are highly important.

Interviews reveal that gains from interdisciplinary projects at high school level remain quite low. The reasons are explained in two ways:

- First way, mostly 9th & 10th grade students take part in interdisciplinary projects and students at these levels are not yet specialized, as expected. This could yield in lower levels of knowledge accumulation at all disciplines.
- Second way, the curricula of 9th & 10th grade students are not in perfect conformance, resulting in narrow aspects on common points while conducting interdisciplinary projects.

For these reasons, in such projects, the expected gains and applicable levels are needed to be well-identified in order to make the most of time and effort while moving towards the goal.

Rather than imposed integration of other disciplines into one discipline taken as basis by one teacher, the interviewees urge upon the gathering of teachers in order to conduct a feasibility analysis for generating, developing and implementing a project idea. In this process, the significance of project content creation, appropriate student level selection, goal identification, timeline generation and detailed rubric preparation are highlighted.

About this subject, an interviewee indicates as:

As far as I know, interdisciplinary studies are the studies that can both take time and require serious work and provide more gains. As I had said, I have never experienced but I only know it theoretically. Actually, I had reviewed STEM instances, they were very tough. That is to say, I do not know how we can perform such a study for 9th and 10th graders, the content could be left simple with 9th and 10th grade gains. (Esin, MI)

Another interviewee points out that:

In our graduate studies, we had done a trial with teacher colleagues from various disciplines. Under those circumstances, even what we did was a sample application at a very easy level. At that time, even we were not able to design and experience an advanced level within ourselves. I think it might be an unnecessary application at high school level, it could be done at primary school and secondary school because at those levels both gains are low and projects can be kept weak in terms of content but I do not think that the content is appropriate at high school or I do not know, it should be a project that is designed in a very good way and the content is set. That is to say, it should be such a project that the time and effort spent by both teacher and student should worth, the content should be suitable for the gains so that it would really work out. (Gülay, BI)

The interviewees also advise that for a school taking steps in this direction, these processes should be led by new teachers, under the control of a committee consisting of specialists in interdisciplinary education.

4.2.3. Study environment

The teachers mention that after some point, the regular classroom environment would not be enough for developing an interdisciplinary program or project. For initial small studies in prototype format or trial studies, a highly developed learning environment might not be needed. However, for broader and deeper detailed studies, technologically equipped and physically appropriate meeting rooms would be required in order to put teachers and students together to perform.

Even though one would expect better meeting rooms and technological resources in private schools when compared with public schools, the teachers who worked in other private school throughout their professional career state that those private schools also lacked necessary infrastructure needed for interdisciplinary studies.

Since departments are located in separate rooms, there is a clear need for an environment that brings teachers together. The same situation applies for students who are expected to do research and share ideas with each other throughout the process.

4.2.4. Teacher and student readiness

For creating the content of an interdisciplinary program, the readiness of teacher and student is of high importance.

According to the interviewees' points, for performing interdisciplinary studies what a teacher needs first is the motivation. This motivation could be obtained and raised by various ways. Alignment of school culture, positive attitude from school management, enthusiasm of colleagues could give rise to teachers' motivation. It is also believed that experiencing the measurable positive effects of interdisciplinary studies over the students would generate high motivation to teachers for the next studies. Motivation could also be provided by the inter-high school competitions designed domestically or abroad. Such events would broaden the horizons of both teachers and students. In addition, interviewees remark that teachers would not need a motivation based on financial resources in order to perform these studies.

Another factor that would impact the teachers' motivation and most importantly the quality of the emerging study is the teachers' professional practicum and fund of knowledge. In the cases that teachers lack experience and knowledge, two paths could be followed:

- An in-house training could be designed by school management and teachers could be trained.
- Alternatively, as mentioned in the Content section, a committee consisting of teachers with adequate experience and knowledge could be formed and the projects could be led by this committee.

In the interviews, teachers emphasize that for performing an interdisciplinary study, rather than students' preparedness, knowledge or experience, the most crucial determinant is their motivation. Considering the fact that teachers can guide the students for the necessary knowledge throughout the program, the willingness of those students becomes the most integral element affecting the performance of study.

Recent changes in the question styles of national university entrance exam also support the gains from interdisciplinary processes rather than the gains from exam-focused learning. These changes stand as strong incentives that motivate students in favor of interdisciplinary methods. Another source of motivation could be the inter-high school project competitions organized by TUBITAK. In these competitions, besides the single disciplines, interdisciplinary categories are also included for encouragement.

4.2.5. Roles

Defining the roles of teachers, students, school management and parents is regarded as a prime factor for proper performance of interdisciplinary studies.

The school culture together with the perspectives of management and parents for this culture was mentioned in previous sections. School management is expected to pursue a role supporting both teachers and students in interdisciplinary studies. Another point about the significance of school management's perspective is that they could have influence on the access to resources and learning environment arrangements during the study period.

Positive attitude from the parents regarding interdisciplinary studies is another vital source of student's motivation. The interdisciplinary studies that are not integrated with the course content yield in extra hours of working at school for students. In such cases, the parents support is directly proportionate to their positive perception towards the project.

Along with the student, teacher constitutes an integral backbone in interdisciplinary studies. First and foremost, teacher should be the planner all along the study. Right beside this role, teacher needs to take on the role of a guide and facilitator among students and colleagues. Teacher should properly convey the information regarding his/her own discipline and should remain in collaboration with other teachers through the project. That is alongside with being a teacher, he/she should also be a learner in this process, taking an active role in connecting with other disciplines as well as canalizing the students. Teacher should provide regular and efficient feedback to students.

On the other hand, the student should be an active learner. By means of strong social connection, he/she should take a two-way role, both receiver and transmitter. According to the interviewees, student should keep openness for both ways in terms of peer guidance. That means in a discipline that the student is strong at, he/she should take the guide role; whereas in disciplinary areas of weaker knowledge, the student should stay open to be guided. All in all, the adaptation of skills important for the student in this process. Moreover, the student need to undertake a reflective role against both teachers and teammates.

4.2.6. Assessment

The efficiency of an interdisciplinary study bears importance in the sense that it provides insight on the future studies; enhances consistency from the points of parents, school, student and teacher; also provides motivation.

Interview results show that interdisciplinary studies should be subject to evaluations in the beginning, continuation and ending of the process. Among these evaluations, the necessity of primarily applying pre-test and post-test is pointed out. “Prior to this study, what had the student learned by means of disciplinary methods only?”, “How much of the desired gains were achieved by the student as a result of this study?”, “In the end, was any benefit or loss observed other than the desired achievement?” The answers of such questions are critical for improving the efficiency and providing correct feedback to the teachers.

It is also stressed that self-assessment, peer assessment and teacher assessment would increase the efficiency through the study. Furthermore, the presentations made by the student along the process or at the end; together with the discussions and debates that the student took place together with teachers and other students would also contribute to the efficiency. It is envisaged that attending a competition with the study and being evaluated among other studies would also create additional benefits.

4.3. Benefits of Interdisciplinary Studies (Aims to Develop)

The second research question is asked as “What are the opinions of science and Math teachers about interdisciplinary approach in terms of its benefits?” With this question, it is aimed to reveal the benefits of interdisciplinary studies.

According to the content analysis, two themes (e.g. benefits to students and benefits to teachers) and 25 codes within the themes have been reached in the coding of the teacher interviews.

4.3.1. Benefits of interdisciplinary studies for students

It has been reflected by science and math teachers in their views that interdisciplinary studies enable many benefits to students in both their social environments and academic lives, as well as 21st century skills' development.

It is known that the problems faced in occupational or academic areas, as well as the in the other parts of daily life do not contain only one discipline. Along the path to solution or development stages of a system, much more impactful and fruitful advancement is achieved when further disciplines are added into the picture. “Why are we supposed to learn this?”, “Where in real life are we going to implement this?”, “For the university program that I would like to attend, what benefit does learning this information provide?” These are the questions from students that come across throughout their educational life.

It has been stated by the students educated with disciplinary approach that they face difficulties when encountered with real life problems or question types including more than one discipline. According to the teachers, by means of interdisciplinary events, students start to see how one discipline concludes a problem when combined with other disciplines. It is remarked that students perceive disciplines more rationally and see them more reachable with the help of these events.

In teachers' views, it is emphasized that students could become more critical and analytical thinker with the interdisciplinary educational approaches and the mathematical literacy could increase.

Teachers express their opinion that students could start to obtain a more holistic perspective against problems hence this could help them reach to more productive results in complex questions. For example, it is noted that a student taking part in an interdisciplinary project is able to show higher levels of importance to personal education and development, also able to adopt more communicative and cooperative attitude in group projects with an open-minded approach.

As known in education, one-size-fits-all approach might leave some students behind in terms of course content. According to Howard Gardner's Multiple Intelligence Theory (Gardner, 2000), people have 8 different intelligence resulting in different learning styles and approaches to courses. Some successful students in non-math courses might feel themselves inadequate in math courses, they are even further lost if there is a teacher-oriented lecturing for math courses.

As per teachers' views, bringing courses with different contents and students with different skills together in a class, project or event with an interdisciplinary approach would enable them have researches in accordance with their own interests and areas. This would also help the students realize how positively this study would affect their perspectives against a course that they struggle or lack the motivation for. They would find out the joy and good in being a part of the whole in the holistic outcome of such a study that they would most probably prefer not to take place if it were an event of one discipline only.

For example, I witnessed physical education and geography courses creating an interdisciplinary project in our school. I think of my own years of studentship, geography was a very verbal course for me, I did not use to like it. If I had been included in such a project during my years of study, maybe it would have developed my verbal skills together with my numerical skills, maybe my point of view towards the course would have changed, I would have learned to look at problems that I would face in the future from a different aspect. Sometimes, it seems like we do not accept that students have different intelligence as individuals, according to a mathematics teacher all of them should be able to do mathematics in the same way, that is so wrong... (Elif, MI)

Moreover, it is expressed in the teacher's arguments that while preparing for exams, constantly doing tests with typical result-oriented approach might also decrease in an interdisciplinary project since the process is deemed as important as the result and more skills could be gained during the process as against the result.

While teaching biology or mathematics or physics, no matter, at the end of the class I ask the question, did he/she learn it or not, done. That is to say maybe with a question of 4 minutes, I am evaluating whether he/she learned the lesson that I taught in 15 minutes. In an interdisciplinary study, the gains do not end with an output that comes out of a project. I think its benefit to the student is the process and these benefits could show off in a long period of time, we should not expect an immediate result, maybe after a couple of project both the student and we will start to realize the gains visibly. (Ahmet, BI)

The benefits of interdisciplinary studies for students are generally illustrated in Figure 4.2.

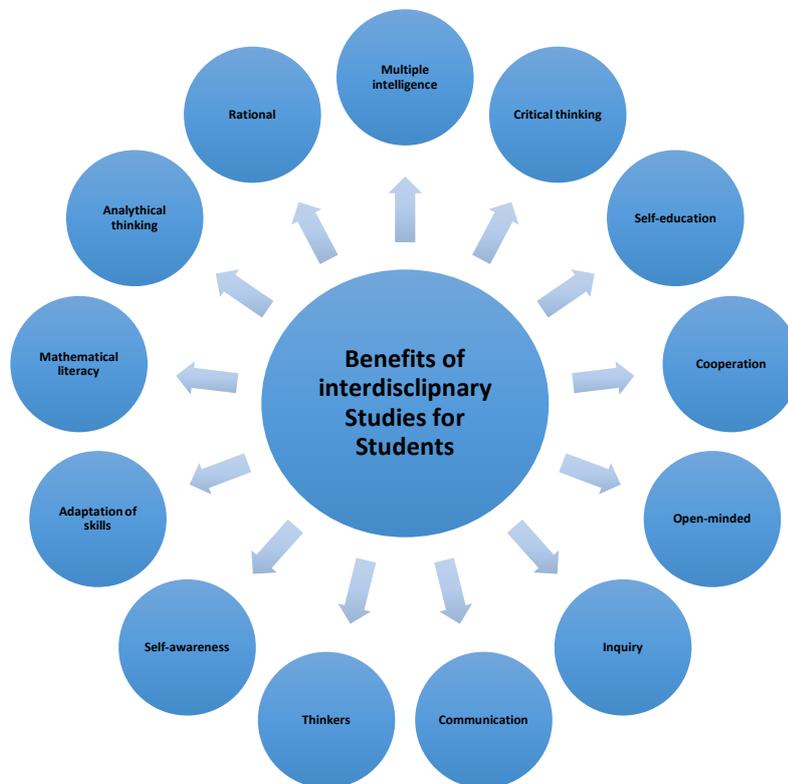


Figure.4.2 Benefits of Interdisciplinary Studies for Students

4.3.2. Benefits of interdisciplinary studies for teachers

From the teachers' opinions, it comes out that taking part in an interdisciplinary study would contribute not only to students but to the teachers themselves, too. Over the years, teachers are bounded with the same curriculum, ending up in occupationally blind mindset, laziness and gripping to the comfort zone. Interdisciplinary studies among teachers could prevent this case by describing more innovative, explorer, questioner and active-learner role. It is indicated that by this way, teachers would start to see the connections of the course with all disciplines and converge to his/her job with life-long learner attribution. By increasing the cooperation among teachers, interdisciplinary studies would, at the same time, promote collaborative and communicative skills, inducing more reflective and open-minded roles.

The benefits of interdisciplinary studies for teachers are generally illustrated in Figure 4.3.

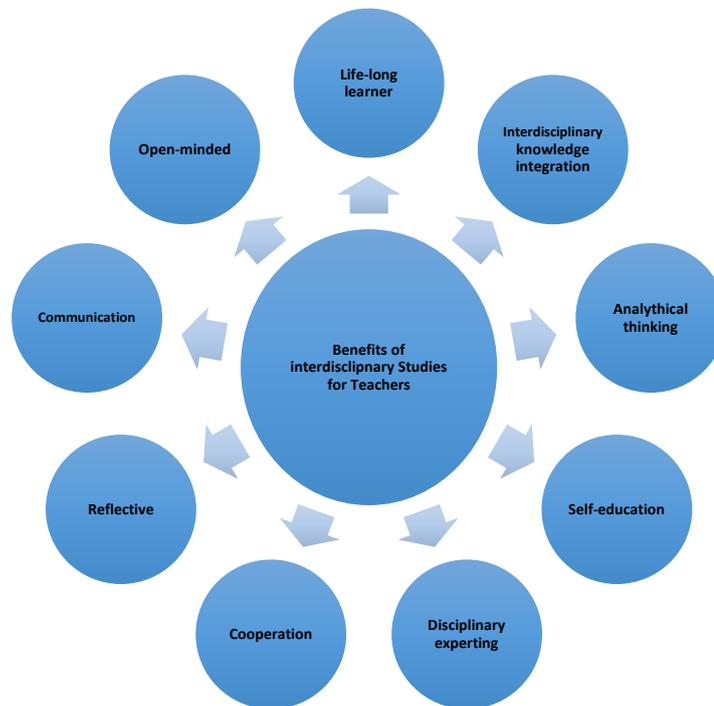


Figure 4.3 Benefits of Interdisciplinary Studies for Teachers

4.4. Restrictions

The second research question is probed as “What are the opinions of science and Math teachers about interdisciplinary approach in terms of its restrictions?” This question intended to uncover the restrictions that prevent to implementation of interdisciplinary studies. In this section, 12 themes have been reached in the coding of the teacher interviews related to the restrictions of interdisciplinary studies and they have been generally described.

As per the observations and arguments, it is identified that not only in public schools but also in private schools with more resources and potentials, interdisciplinary studies are not conducted at a substantial level. Both literature and views of teachers reveal that interdisciplinary studies drive students to higher level of thinking and improve

their cognitive level of thinking. Yet, these methods that are well capable of helping students establish links between disciplines and enhance success in solving real life problems are not sufficiently implemented at high school level. The reasons behind this lack of implementation are investigated in literature as well as the teachers' points of view.

Restrictions encountered or likely to be encountered in interdisciplinary practices are illustrated in Figure 4.4.

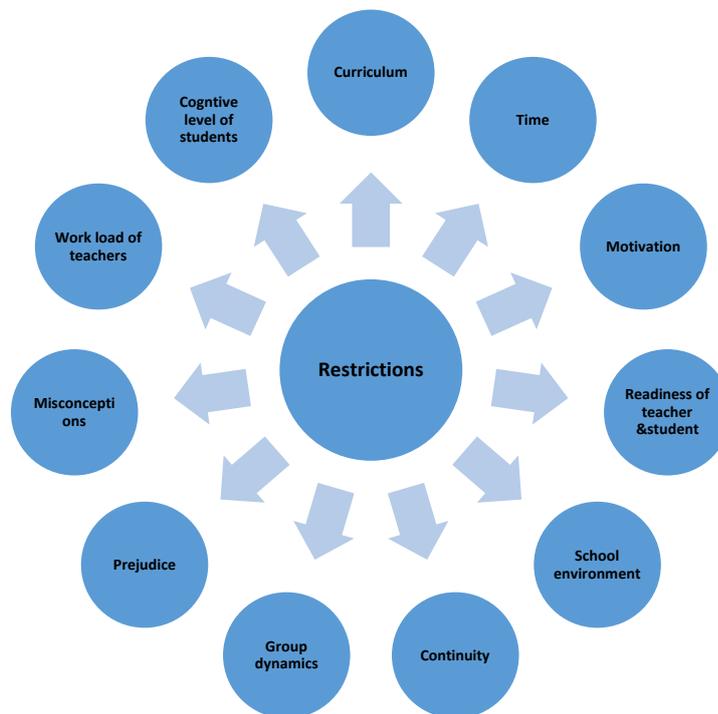


Figure 4.4 Restrictions

4.4.1. MoNE curriculum

In interdisciplinary studies, there are separate gains aimed for each and every discipline related with their own areas, in addition to the process gains of the project as a whole. These gains are expected to comply with the level of students to perform the study, that means compliance with the concurrent or past curricula.

According to the curriculum of The Ministry of National Education (MoNE) every single discipline has a spiral structure. For example, in physics curriculum, a student

selecting his/her study area while learning basics at 9th grade. An advanced version of these basic information would follow up at 11th grade. Similarly, some of the content taught at 10th grade continues at 12th grade. According to MoNE curriculum, in secondary school, students select their specialization areas. Hence, the instructions given at 9th and 10th grades become more advanced at 11th and 12th grades. At these grades of 11th and 12th, students begin preparing for National University Entrance Exam, which is the most critical factor for studying a university in Turkey.

The teachers' views point out that the major reason for not including interdisciplinary studies in MoNE curriculum is the disharmony of both science and math courses throughout the grades from 9th to 12th. For instance, considering interdisciplinary studies at 9th grade, some of the gains from these projects are for 9th grade only. However, some of the gains are for 10th, 11th and even 12th grades. Due to the fact that 9th and 10th grade students have not yet selected their specialization areas, the studies at these early grades are intentionally kept at low difficulty level. In this case, expected gains in high level thinking and critical thinking could not be achieved, ending up in an anticipated overall inefficiency. Teachers noted that such scenarios could be encountered in science and math courses mostly. However, they also stated that for more verbal courses such as history, philosophy and literature, compliance with curriculum could be achieved at higher levels or even though the objectives do not match, students could carry out their research with higher objectives. More comprehensive studies could be performed at the levels of 11th and 12th grades; however, students at those grades are reluctant in taking part in such studies. This is due to the upcoming national university entrance exam, they prefer to integrate their time with the activities such as doing tests and closing gaps. One of the teacher's remarks as follows:

I do not lean towards 12th grade students for such studies because their goal is changed by then. It would be the best to perform these studies at earlier stages. 9th and 10th grades are quite appropriate. At 11th grade, delinking occurs slowly, they register to the courses for university entrance exam. But with the help of good planning, why not? (Mert, PI and DHI)

Regarding the reasons behind the low levels of interdisciplinary studies, interviews point out the inflexibility of MoNE Curriculum as its second negative side. Every year, there is an intense curriculum to be completed in a limited timeframe. This curriculum

is in a specific sequence and some sections require highly detailed explanations taking more time than planned. In order to balance, some sections are skipped faster than usual, resulting in lack of comprehension among students. In this case, students tend to memorize rather than understanding the logic behind. Instead of setting up cause-effect relationships, they prefer to solve more test questions, experience more question types and expectedly memorize them.

One of the teachers states as follows:

At some levels, curriculum is very intense. At some levels, it ends earlier, creating an extra time. The curriculum and related national exam should be elaborated and these information should assure trust. One year, we intend to increase events, saying that the important thing is making students comprehend the logic with daily life connections and student-centered education. The very next year, such a question pops out at university entrance exam, sometimes even out of curriculum and being cancelled, that student sees and says: "Teacher, you have not shown us this type of questions, solve more questions for us and let us solve, too." We leave the experiment, the event aside and start solving questions. (Esin, MI)

Another teacher who implemented different curricula lays stress on the flexibility:

In my previous school, I implemented ICGSE, IB programs. First of all, they directly put the project into the middle of curriculum. One way or another, you have to do that with the students. Secondly, even the questions are related with daily life. There were questions giving examples to interdisciplinary connections. Thirdly and the best of all, for example, at ICGSE curriculum of the first two years at high school, it says here are our objectives, finish them in any sequence and in any way you prefer, but finish them in two years. This is a great flexibility and you are more open to any kind of events. However, let us consider MoNE Curriculum, too. Putting the flexibility aside, this year, even the interim exams are decided to be made as a common exam nationwide. That means something like they control you and your students in every three months. If the curriculum is caught up, you are toast! (Elif, 4FM32, MI)

In the views of three teachers, upon the flexibility of ICGSE curriculum and the comments about its convenience to interdisciplinary studies, when this curriculum is analyzed by the researcher, it has been observed that in this curriculum that is implemented at the age interval of 14-16, besides main science and main mathematics, from accounting to computer science, from agriculture to arts, there are various elective courses and according to the selection the schools that follow this curriculum, students can create their own curriculum out of these elective courses in a way they

prefer and that enables flexibility to the teachers in teaching until the general exam to be conducted after two years.

In the statement from Cambridge International website, it is indicated as:

Cambridge IGCSE offers a flexible curriculum, with a choice of over 70 subjects in any combination. There are no compulsory subjects and students are free to study a range of subjects. Giving students the power to choose helps to motivate them throughout their studies. (URL-2, 2021).

When MoNE curricula are analyzed, no flexibility is observed, the ordering of the gains in the chapters and the time it takes are stated in no uncertain terms. The intensity of gains that are squeezed into an average period of 16-18 weeks is also underlined.

4.4.2. Time and workload of teacher

In order to perform interdisciplinary studies, the teacher and student might be bound to study both in and out of school time. Although this situation could be handled easier for the students, it is observed as an important drawback. Firstly, the teachers of the disciplines taking part in the study are expected to find out a common time slot where none of them have classes and in this slot, the interdisciplinary study plan should be created in great detail. Until the stage of meeting the students, it is almost impossible for teachers to decide on the common slot and sustain the meetings in a continuous manner when it is considered that they all attend at least 25 classes in a week. Secondly, teachers solely face difficulties in creating time for the preparation of this plan. There are approximately 150-200 students for each teacher and there are many time-consuming related activities; such as individual follow-up on students, general etudes, individual etudes, in-term performances and exams to be prepared and assessed. For these reason, teachers remark that they stay away from interdisciplinary studies. In the interviews, one of the teachers explained her opinion as follows:

Since we are a school teaching in English, we generate our own books in English language and in compliance with MoNE Curriculum. We have our own question bank and we prepare our performances. There are many things similar to these ones that we cannot use an already generated option. We have resource problems since that need to be created from the beginning and the worst, the curriculum changes in every two years. Some objectives are remove, some are added. During the whole summer, we edit new books and prepare new performances. That is to say we change what we have even before improving it. In the time spent for these things, we could have achieved much more! (Eren,

CI)

In his views, another teacher mentioned that there is a time problem however teachers' self-motivation could overcome them all:

Yes, we work hard. Yes, it seems like we do not have enough time for extra activities but if desired, I believe that all projects can be done. By the nature of the profession, teachers get lazier as teaching the same things every year, we neglect that. Teacher does not want to get out of the comfort zone by creating excuses. Why should he/she get out if the student got into a university somehow, if the parents are satisfied, if the student is satisfied, if the management is satisfied, we are inclined to maintain the same system, say it 5 years or maybe 10 years. The ages change, the upcoming student change from one studying style to the other. (Fatma, BI).

4.4.3. Student and teacher readiness

According to teachers' opinions, preparedness of teacher and student is a significant factor in performing interdisciplinary studies. Usually, teachers prefer not to step out of their comfort zones due to their lack of education regarding the planning of interdisciplinary studies or their lack of knowledge about both their own curriculum and the other curricula. Only three of the interviewees declared that they were educated during graduate studies about how to make an interdisciplinary project. In this education, they were not provided with a theoretical information, they planned on a sample and did not put it into practice. Therefore, teachers generally cannot decide on how an interdisciplinary study can be designed, how they should work on a project or a problem, which student levels are the most suitable for this project or with which disciplines they can cooperate.

In the interviews, a teacher working in managerial role states as below:

I do not think that our teacher has sufficient knowledge on this subject, they do not have education and the era is changing, the question types are changing, it is also stated in the curriculum that the ministry sent, prepare your students to real life, ask that type of questions, as teachers do not know about the curriculum, they do not know how to correlate the real problems with the curriculum they will teach. (Feryal, MI and DHI)

Another teacher indicates that preparedness of teachers should be satisfied hardly if needed:

I think we should not give our fresh graduates their diplomas until they receive

their specialty just like doctors, for 3-4 years. For example, did the teacher attended classes at all levels until receiving his/her specialty, did he/she specialize in his/her area, is his/her curriculum knowledge is sufficient, how is he/she at assessment and evaluation or was he/she able to make an interdisciplinary project, so on and so forth... (Fatma, BI)

The preparedness of students is stipulated depending more on the teacher. In this process, it is thought that teacher's leading the way for students, step by step neat planning of the project and project's having guideline or rubric prepare the student to the process in a better way.

Due to the spiral structure of the curriculum, in an advanced level and comprehensive interdisciplinary project, it is expressed that when compared with 9th and 10th grades, 11th and 12th grades that have already selected their areas and progressed with the curriculum could study more efficiently with a higher level of preparedness however they may prefer not to take part in the process due to the rush of university entrance exam.

4.4.4. Motivation and continuity

Most of the teachers stated in their views that for an interdisciplinary study, the teacher needs to have an inner motivation. Nevertheless, in the cases of not developing this inner motivation; the teacher's limited time availability, the continuous changes in the curriculum and not knowing how to design the study are shown as the reasons behind.

An interviewee comments about the inner motivation as:

I find it necessary to do something special about teacher motivation because if the teacher knows the benefits of the study both to himself/herself and to the students, then the motivation is already generated. The school, even if it is a private one, cannot include its teacher into a process that he/she does not believe in. (Ahmet, BI)

Another teacher lays stress on the school's commitment for teacher motivation:

I think teacher should want it by himself/herself however we see that he/she does not want (laughing), then in this case, the school will want, such a thing would not work in state schools but in a private school, when the management want, it means that the teacher's motivation will be provided forcibly. Of course, at one point, by seeing the results, teacher can start enjoying and developing inner motivation but for the start, it is difficult to find that motivation under these working conditions. (Zehra, MI)

It is emphasized that in order to ensure student motivation, firstly the motivation of the teacher participating in the project should be high and they should be willing. In the speech of an interviewee, it is stated as:

What can be done in order to keep the student in the project and keep motivated? A difficult question but this is valid for everything, not only interdisciplinary applications. As a teacher, if you own the task and if you are willing to go till the end, you lead them all and serve them as a model. First, teacher himself/herself becomes the researcher, structure and leader; owns the project and feels that energy inside, teacher knows that the student will not give up on the project easily and starts to enjoy like teacher, too. (Fatma, BI)

Many teachers believe that continuity to the project and active attendance of students can, at the same time, be obtained by performance grades:

If I tell the student that percent of your performance grade will be from this project, it is okay to provide motivation or not, but the continuity will surely be provided. Of course we cannot do that, rather we do not want to do that because at the moment we say grades, the student becomes reluctant. Also, we cannot identify which discipline will decide on the level of commitment within the project and how this commitment will be graded. In our 10th grade elective course,¹ we still discuss on which course should give grades at which level and we cannot compromise. In an interdisciplinary project, most probably, we would get totally lost. (Eren, CI).

Another factor affecting student motivation and commitment to the project is shown as student's creating a product, sharing it with others and receiving appreciation.

It is also asserted that the events like participating in a contest with the project or exhibiting the products of the project and as a result, getting appreciation from both friends and teachers could increase the willingness towards interdisciplinary projects.

4.4.5. Prejudice and misconceptions

Prejudices and misconceptions that can pose obstacles for the applicability of interdisciplinary studies are encountered in the interviews.

¹ 10th grade students are required to choose the field of TM (Turkish-Mathematics) or MF (Mathematics-Science) at the 10th Grade level. After this selection, additional courses are given for MF students in Physics, Chemistry and Biology disciplines to prepare them for the 11th grade, but their grading is designed together by the Physics, Chemistry and Biology departments.

Two teachers that never participated in an interdisciplinary study claim that these applications are actually waste of time and the gains for the students will remain low.

A teacher states that:

There are many gains, as I understand these projects will consume plenty of time from both teacher and student, then it should be very valuable but we shall select two or three of that many gains and give our months to it. I think STEM projects, interdisciplinary projects, these things are being exaggerated, especially for the high school level. However, it may be more appropriate if they are done at the university or it may work with less gains at elementary school level. (Gülay, BI)

Another teacher argues that interdisciplinary studies are not process-oriented but result-oriented instead; stating that in such implementations students would like to study in a result-oriented way and both teacher and the student would focus on the product.

Another teacher mentions that interdisciplinary studies are abstract and there are much different ways to materialize gains or classes better.

4.4.6. Group dynamics

In interdisciplinary projects, both teachers cooperate and the students work in groups. The interview results reveal that the teachers having less willingness to collaborate is another thing in the way of interdisciplinary studies. The first reason behind this lack of willingness is the fact that the teachers from various disciplines are not able to get to know each other since there is no place, room or event in the school where they can have time together. The second thing is that not all the teachers participating in the study wish to work at the same dynamics. An interviewee indicates that:

We were to perform a project but not an interdisciplinary project. Several teachers, we needed to get together, some attended the meeting and some did not, some completed on time and some did not. The work was delayed, since we were colleagues, we did not have a word to say to each other. Since we were not superiors, we were not able to warn, it was not welcomed. Hence, the one who did well undertook the work of all. We have faced such cases many times, we tell students that group work is important, actually can their teachers do the group work? (Feryal, MI)

The interviewees underlined the group dynamics of the students as well. They indicated that many projects ended due to the fact that students were not able to

maintain a proper study with each other. Although there are teacher views that advocates the students should be at the same level, there are also views arguing that the groups should be created from students with totally different levels and interests:

In STEM, students should choose the project, if we are to announce to the class that we will make a STEM project, there are many students with low mathematics & science competence and many students that will not select that area especially among 9th and 10th graders. These students cannot progress in the project, actually what they want does not happen, then they start complaining about each other like “my teacher, two students are working and three students are sleeping.” Group study also does not proceed appropriately; the whole project rolls up on the student with higher interest. Therefore, I think it is important to have students with equal interests and especially with equal levels. (Mert, PI nad DHI)

We were involved in a project but the project design did not belong to us. It was a Poland originated Erasmus plus project. In the study, we were given a student group description in a way to select all students from the ones with low academic success and we selected the students accordingly, it was seriously a big success, the academic level of students might be low but they were in harmonious and they got carried away as they see that they were creating a product. We carried out the project for three years and received very nice feedback. (Samet, PI)

I think they should be selected from different levels and different relevancies, a mixed group can be better but it works if a good rubric is generated or the teacher should be followed up all the time otherwise one member of the group works and the other one does not. Since they are friends, they do not complain about each other. This is a frequently-encountered situation even in normal classes. I say let’s carry out an experiment and divide the students into groups. From a group of 4-5 students, there is always one student that does nothing at all. (Bilgi, CI)

4.5. Education of Teacher

In relation to the third research question expressed as ‘‘ What are the opinions of science and Math teachers about teacher education of interdisciplinary approach?’’ 4 themes and 4 codes emerged.

Based on the analysis of the interview data, for an interdisciplinary education to be designed and sustained, it is important for teachers to be able to manage the design phase well and offer the correct guidance to the students throughout the process. In this regards, when it is asked to the teachers whether they had such a training or course regarding this subject, they claim that they have not met such a content in their

bachelor studies. Those who have their Master's degree from Bilkent University Curriculum and Instruction Program mentions that since they took a course related with IB DP (International Baccalaureate Diploma Programme), they directly prepared a sample plan about interdisciplinary education and applied among the teachers who took the course. They also state that they have not had an in-service training at the institution they work for, they have had a training about STEM (Science, Technology, Engineering and Math), which can be classified as the closes to interdisciplinary applications.

The teachers were also asked about their willingness to undergo a training, its timing and content design. The answers reveal that the training is certainly necessary, even though there is no expectation for project generation continuously, teachers should be able to integrate this training to the classes and it would have positive contribution to motivation increase.

About the timing of the training, the opinions are concentrated against integrating the training with the undergraduate education and it would be more efficient to have an in-service training right after starting the professional life. One of the teachers explained her view as follows:

I cannot even remember most of the courses I took in undergrad. The reason is beyond the time that has passed since then. First, we were unable to comprehend or feel how important these things could be in a real class since we have not yet started the professional life. Second, it was about our rush to finish the university. Towards to last years, in an effort to graduate, you start saying I shall pass the course, no matter how. (Bilgi, CI)

According to the interview results, following items are highly recommended to be included in the content of designed education about interdisciplinary studies:

- The philosophy of interdisciplinary education
- Theories based on
- Benefits for students and teachers
- Sample plan and applications (there should be sample for each discipline)
- Workshops

A teacher in managerial role argues that the planned education needs to spread into a long period of time and as an example, the prepared projects should be tried with the students for one year within the education and in order to have it rooted into the school culture, there should be participation from all disciplines.

CHAPTER 5

DISCUSSION AND IMPLICATIONS

In the first section, the results of the study are discussed in detail with reference to the relevant literature review. In the second section, the future implications for practice and recommendation associated with the results of the study are given.

5.1. Discussion of the Results

In the present study, the purpose is to demonstrate the feasibility of integrating the interdisciplinary methodology into education in high school science and mathematics courses and to discuss the possible obstacles to the successful integration of this method into the education system, the needs, competencies and tendencies of teachers to teach with an interdisciplinary approach and the limitations that prevent the application of the interdisciplinary method are emphasized. This section presents the discussion of the results in line with each research question successively.

5.1.1. Applicability of interdisciplinary studies

The first research question is asked to explore the applicability of interdisciplinary approach in high school science and Math education. While the implementation of interdisciplinary studies is strongly recommended by MoNE and it is emphasized that this should be done in the curricula as well, the analysis of documents. The necessity of applying interdisciplinary studies is explained in detail in the literature. Today, depending on the development of technology and globalization, the needs of individuals and societies are changing, and accordingly, education systems are constantly changing and developing. As a result of the rapidly developing modernization of the age, it has gained importance to educate original, creative and entrepreneurial individuals who can renew themselves and adapt to developments, in order to create the necessary information society, and societies have begun to focus on new educational approaches that will meet these needs (Yıldırım, Şahin & Tabaru,

2017). Finland, which pioneered the implementation of many new educational approaches, made a radical change in the education system by switching to an interdisciplinary-based education system and the United States followed this lead by combining systems and theories in the field of science, education and engineering. (Bastos, 2017). In line with the radical curriculum changes made in 2013 in Turkey, constructivist-based and spiral curricula were prepared in 2015 and 2018 that support students' 21st century skill acquisition. When the secondary school Chemistry, Biology, Physics and Mathematics curricula are examined, it is seen that while these curricula are being implemented and the objectives are being measured, it is recommended to use the measurement and evaluation tools as well as instructional approaches that will prepare the students for today's world, develop their individual and entrepreneurial natures, and enable them to search for solutions to complex problems (MoNE, 2018).

As stated in MoNE's STEM Education Report (2016), interdisciplinary studies with science, technology, engineering and mathematics courses are not given enough importance in Turkey. In order to overcome this problem, in addition to studies such as training teachers on interdisciplinary teaching programs, the curriculum should be corrected and re-planned. In furtherance of MoNE's mentioned report, literature also show that researches on interdisciplinary studies in Turkey are few in number, although they increase every year, and studies in the field of science-mathematics are also less in number compared to studies in the field of social sciences (Turna & Bolat, 2015).

Based on the observation and interview results, it was observed that interdisciplinary studies are not carried out in the fields of science and mathematics, in classes only the relations of a discipline with other disciplines are emphasized in some subjects and an advanced level study is not included. Figure 5.1. It summarizes the results of observations and interviews about the applicability and inapplicability of interdisciplinary education at MASELSA school.

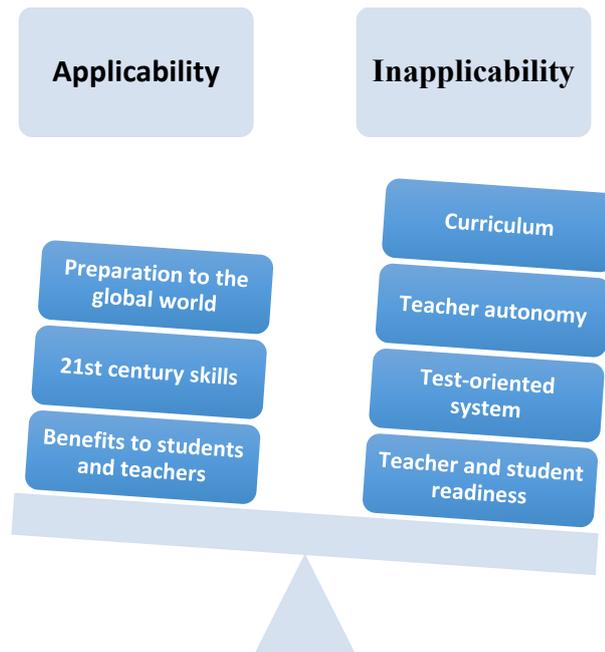


Figure 5.1 Applicability of Interdisciplinary Education in MASELSA School

This study also aims to reveal the requirements, benefits and restrictions of the application of interdisciplinary studies through the answers to the second research question. According to the answers given by the teachers to the interview questions and the observations made throughout the school and in the lessons, several factors related to the implementation of different interdisciplinary studies emerged and are discussed in the following paragraphs. Observations results show that the most dominant methods used in the lessons are still teacher-centered and lecture-based. When the teachers' opinions were examined, it was revealed that some teachers only knew the interdisciplinary practices at a certain level theoretically and never applied them with the students. According to the results, it is seen that there are several reasons for this situation. First, although MASELSA is a private school, it can be concluded that the reasons for the insufficient interdisciplinary studies in the school are the lack of knowledge of the teachers and the lack of attention given to interdisciplinary studies due to the exam-oriented education system in Turkey. The findings also revealed that high-stake exams, such as the university entrance exam, hinder interdisciplinary studies. In other words, preparing students for possible questions in high-stake exams limits the freedom and enthusiasm of teachers. Teachers focus on the exam instead of teaching the subjects in their own way. In this respect, they refrain from allocating

time to interdisciplinary studies. It can be concluded that the instructional approach at the MASELSA School can be called more measurement-driven rather than interdisciplinary teaching. The school's strategic plan also seems to support this finding. When the strategic plan of the school, which is revised every 3 years, is examined, it is found out that all students are targeted to be in the first 30,000th ranking in the university exam, and therefore, a student profile is created who only want to solve the test quickly and accurately about the disciplines. The literature also supports this finding. Critics of high-risk exams claim that they narrow and distort the curriculum and send the message that the primary purpose of learning is to score well on tests (Nichols & Berliner, 2008; Mika, 2005; Burger & Krueger, 2003).

In a tone to explain this approach of the school, Wall (2000) states that although educational administrators find high-stakes tests useful in order to strengthen the reputation of their school, these tests have harmful effects in terms of both increasing anxiety in the classroom and not providing educational profit for students and teachers.

When the teachers were asked how they would approach interdisciplinary studies, all teachers stated that they would approach positively and support them, but it is seen that the teachers also want to teach students with a focus on national exams and high stake-tests. In other words, teachers feel pressured to make their students do well on high-stakes exams and therefore neglect work outside of exam preparation, including interdisciplinary work. The 12th grade teachers who participated in the pilot study of the thesis, stated that the 12th grade teachers cannot waste time with such practices, that the 12th grade is completely based on the cooperation of the private tutorial and school, test-solving and repeating separate topics about disciplines, and that the teacher is far from such practices, emphasizing that the student would not want to do it even if it was wanted to be done. The literature also reveals that teachers feel increased pressure when high-risk testing programs are applied (Barnes, 2005; Clarke et al., 2003; Pedulla et al., 2003).

In the interviews, teachers stated that there are differences in the applicability of interdisciplinary studies according to grade levels. Many teachers emphasized that the 9th and 10th grades would be the most suitable for the implementation of interdisciplinary studies. However, the teaching in 11th and 12th grades is exam-

oriented, it is very difficult to carry out interdisciplinary studies in these grades. It is found that the students of the 9th and 10th grades were not included in the interdisciplinary applications, moreover the homework and worksheets assigned during the semester are still aimed towards test solving. The literature also shows that student-centered education practices are still not sufficient in the Turkish education system (OECD, 2020; Acar-Erdol, Yıldızlı, 2018). In support of this situation, educators, parents and students focus on academic success by internalizing the evaluation process of learning, and this condition advocates the existence of standardized tests that measure academic success in a limited and problematic way (Taneri, 2019).

Moreover, Aksoy and others (2014) stated that in an education system where exam success is the main determinant, there are studies that centralized exams do not only standardize the curriculum, but also negatively affect the assessments and teaching techniques used by teachers in the classroom. Relying solely on traditional lectures is not effective in promoting interdisciplinary studies. In the future, students need interdisciplinary collaboration skills if they are to work in an interdisciplinary team, and disciplinary interpretation and synthesis skills if they are personally integrating knowledge from more than one discipline. However, using only the traditional teaching method is not sufficient for students to acquire these interdisciplinary skills. This situation limits the purpose of teaching to the ability of solving exams rather than preparing students for the changing life and gaining 21st century skills (Aksoy, Akgündüz, Demir, Tunacan, Türk & Uğur, 2014; Au, 2011; Kılıçkaya, 2016; Ömür & Bavlı, 2020).

When the documents of philosophy, corporate culture, visions and missions of the school are examined, although it is clearly seen that the 21st century skills that the student profile school wants to educate will have are equivalent to the skills that will be gained as a result of interdisciplinary practices and the competencies desired by MoNE curricula, it is observed that teaching activities that will develop these skills are not included within the formal education.

According to the observations and document analysis at school it was seen that some of these skills are tried to be gained through social clubs, some of them are tried to be

gained through competitions or projects that deal with a single discipline such as TUBITAK competitions or term project papers. For example, while the term project assignments on which the student has been working in depth for almost a year consist of research questions based on discipline in physics, chemistry and biology, whereas a test book is required to be completed as a project assignment in mathematics. In summary, interdisciplinary studies are only applied as non-curriculum activities with certain students. Activities designed for school curricula in formal education are selected to support success in the standardized test. Kellaghan, Madaus, and Airasian (1982) criticize this situation and state that standardized testing makes the curriculum narrow and leads to rigid practices. There are also studies in the literature that support the design of interdisciplinary studies as non-curricular activity. Interdisciplinary non-curricular activities can be designed by going beyond the structured boundaries and disciplinary approach in today's education system, as they can be more flexible and adaptive than formal curriculum activities (Chisiu, 2013; McKeown and Hopkins, 2016, as cited in Rushton and Batchelder, 2019). The challenges of designing interdisciplinary studies as a non-curriculum activity can be shown as the fact that learning lags behind the core-curriculum subjects, it is not valued as much as formal curricula activities, and therefore it is not sufficiently supported by both the school, the parent, the teacher and the student (Rushton & Batchelder, 2019).

In their views, the teachers also stated that due to the fact that the questions can go out of the curriculum in the national exams, the objectives of the curricula are not very clear, etc., they teach their curricula in a more detailed and by the reason of adaptation to ever-changing curricula, there is no time left for interdisciplinary studies. In this case, there arises a difference between the implemented program and the official program. It was observed in both the teacher's views and the school observation that some of the subjects in the curriculum are covered in detail and more than the objectives they have. This finding is not compatible with the related literature. The results of the evaluation research conducted by MoNE on national curricula in 2020 show the opposite of teachers' views in terms of objectives; although some physics teachers stated that the objectives in the curriculum and textbook contents are not compatible with the national exam, in general science and math teachers find the objectives in the curriculum clear, sufficient and comprehensive. In that research, on the other hand, some science teachers stated that there is no room for doing

comprehensive activities that will take time (MoNE, 2020). It is possible to see the effects of teachers not using the renewed and lightened official curriculum in the literature as well. In the five concurrent curricula described by Posner, it is observed that teachers do not implement the changed official curriculum, but still use intense old curriculum and they cannot find the time for student-centered activities; while teachers apply an “extra curriculum” in the courses such as science and math that aims to be successful in the national exam, they also create a “null curriculum” by keeping students away from activities that will affect their cognitive and emotional development (Posner, 2004).

The findings also revealed that teachers mentioned the lack of resources regarding the inability to implement interdisciplinary studies. According to the findings, the teachers needed documents that could include case studies in curricula for interdisciplinary studies or that could draw a guiding map for the beginning, but they could not find supporting resources on this subject. When the relevant literature is examined, although there is no general study on interdisciplinary studies, there are documents and in-service trainings prepared by the Ministry of National Education on STEM education based on interdisciplinary foundations. Among these documents, in the "STEM Education Teacher's Handbook", the final version of which was published in 2021, general information about STEM education and how STEM projects can be carried out in schools are explained step by step (EBA, 2021). Nevertheless, the document analysis on the curricula supports the views of teachers; in Physics, Chemistry, Biology and Mathematics curricula, no source or study sample has been found on interdisciplinary connections or studies to be performed (MoNE, 2018). In addition, when the latest studies are examined, it has been determined that teachers lack resources while establishing interdisciplinary connections during STEM practices (Kaya & Ayar, 2020). The scarcity of resources that the teacher can provide information on in the planning process may negatively affect the ability to use interdisciplinary approach and integrate it into the curriculum (Adler & Flihan, 1997). In the results of this study, although no difference was observed between the views of mathematics and science teachers on the feasibility of interdisciplinary practices, it is also stated that there are fewer studies and sources in the literature, especially on the discipline of mathematics and interdisciplinary studies (Yarker & Park, 2012; Adler & Flihan, 1997).

In the interviews, the importance of the teachers' preparedness in order to carry out interdisciplinary studies is also mentioned. Teachers state in their opinions that they may need an expert support and/or in service training in the planning and implementation of such a comprehensive study. Also, although the teachers state that the MASELSA school is open to new applications and assessments, according to the interview and document analysis findings, it was observed that traditional evaluation methods were given more place in the MASELSA school and teacher-centered practices are still used in physics, chemistry, biology and mathematics courses. In a way to support this situation, literature shows that, there are studies on the fact that teachers prefer traditional assessment and evaluation methods in which they see themselves as more competent in the classroom and they need in-service training in using alternative methods (Gelbal & Kelecioğlu, 2007; Çelikkaya, Karakuş, & Öztürk-Demirbaş, 2010; Karakuş, 2010; Acar-Erdol & Yıldızlı, 2018). In this case, by not going out of their comfort zone, teachers prefer assessment types that they have more knowledge about and have been able to apply professionally for years. In the literature, it is seen that some teachers prefer lecture-based teaching because they can control the classroom better and they will not encounter any unexpected situation or problem. Also, it is stated that they do not want to go out of their comfort zone and they think about their own performance rather than student learning (Rasmussen, 2016). Benzehaf (2016) also emphasizes that teachers should follow new approaches in education in order to adapt to a postmodern globalized age. In the study, it is argued that by getting out of their comfort zones, teachers need to bring teaching and learning processes to the most efficient level for students and they should foster intrinsic motivation for self-development, even if they do not have extrinsic motivation.

In the interviews, it was revealed that evaluation is another important issue for interdisciplinary studies and specifically what needs to be evaluated and there are uncertainties about how this will be measured. Teachers need to know what criteria are needed to set clear expectations that can be used to evaluate learning in interdisciplinary studies. Interview results show that since teachers never tried to do an interdisciplinary study with students during the academic year, only try interdisciplinary project in extra-curricular or non-curricular activities as a club activity with certain students who have interest in the club or activity, therefore teachers never formally evaluated the results of an interdisciplinary study in a class.

They stated that they would have difficulties while giving grades to interdisciplinary projects. It is mentioned that it is easier to do an interdisciplinary project as a club activity, but it will be difficult to score which discipline and how in an interdisciplinary project for an educational process where a formal grading is expected during the term.

Although researches and examples on how to assess interdisciplinary studies are increased, there are studies in the literature asserting that it is not an easy process to formally assess these practices (Drake & Reid, 2018). The challenge in assessing interdisciplinary work is to translate vague criteria into a concrete, observable and therefore evaluable skill, behavior or attitude. According to Mansilla, Feller and Gardner (2006), the evaluation parameters of education based on a tight disciplinary system will not be sufficient to assess an interdisciplinary study.

As assessment methods in interdisciplinary applications, there is a need for methods that will enable students and teachers to do self-monitoring and self-reflection, increase the motivation of the student and provide descriptive feedback, and include the student actively in the assessment process (Moss, Osborn, Kaufman, 2008). In the interviews, the teachers also emphasized the necessity of evaluating the process well and giving regular feedback to the students in interdisciplinary studies, in order for the process to proceed smoothly and for the students to get efficiency from these applications. In the literature, it is also mentioned that interdisciplinary studies should not be measured with result-oriented evaluation methods. (Mansilla et al., 2006). According to OECD (2008), instead of the "assessment of learning" methods, which only show whether students have learned and involve them in the assessment process only with a result-oriented approach, by not providing feedback to the teacher or student to improve learning or teaching techniques, "assessment for learning" methods should be preferred, which develop 21st century skills and enable the students to evaluate themselves, by providing information not only about the result, but also about the process and the improvement of the quality of the process.

Another obstacle to the feasibility of interdisciplinary studies is seen as teacher autonomy. Teachers state in their interviews that other stakeholders have a say more than themselves in the making of great works such as interdisciplinary education applications. While it is stated that the national exam success in private schools has a

crucial importance, especially at the high school level, it is also indicated that the studies to be carried out in this context are considered more important by both the school administrators, the parents and the students. In this context, it is desired that the student receives more disciplinary education with a focus on test-solving and the teacher is not well recognized in this matter. In the TALIS (2018) report, Turkey is defined as one of the countries with the lowest teacher autonomy among OECD countries. The professional knowledge and skills of the teacher, the autonomy he/she has in addition to the methods used in education and training and the curriculum he/she applies are shown as very important factors for both the development of the school and the success of the students (Pearson & Moomaw, 2005; Yazıcı, 2016). When the Finnish education system, which is shown as an exemplary country in integrating MoNE's interdisciplinary education into the curriculum, is examined, it is seen that teacher autonomy and learner autonomy that develops with this autonomy play an important factor in the success of the system (Hazır, 2015). For example, teachers in Finland and Singapore have autonomy such as making changes on the curriculum, creating their own curriculum, being flexible in assessment and evaluation practices, and not being national exam oriented (URL 3, 2021). The findings of this thesis are similar to the literature. According to the interview findings, teachers are not autonomous in terms of making changes in the curriculum. The teachers mentioned that some sorting changes should be made in subject headings of the curriculum in order to carry out interdisciplinary studies, and that the teacher should be given the right to choose the measurement and evaluation methods that they will use, and that the high school education should be more process-oriented and integrated with the applications that will help students obtain the 21st century skills rather than focusing on the results of the exam to be taken at the end of the 4th year. However, the teachers do not have the required authority for adapting curriculum to situational conditions and that the school they work allows for a certain level of assessment changes are also indicators of low teacher autonomy.

On the other hand, although the teachers stated that they were not autonomous in terms of making changes in the curriculum so that they could do interdisciplinary studies, it was observed that they did not have a desire or effort to be autonomous. This view coincides with the fact that teachers feel responsible to the administrators, colleagues and students for curriculum design, material selection etc. and at the same time

teachers do not want autonomy because it will increase their workload substantially (Yıldırım, 2017).

The significance of school autonomy also emerges in the feasibility of interdisciplinary studies since it can also affect teacher autonomy. According to OECD PISA data (2013), the education of schools that can choose which teacher to hire, choose which books to teach, regulate where and how to spend their budgets are more successful, but according to PISA results, the autonomy of schools in Turkey ranks the lowest among OECD countries in making decisions about curricula and assessments. Although private schools in Turkey have autonomy in selecting teachers and arranging budgets, changes cannot be made in a school where MoNE curriculum is used and the national exam success has become the focus, at the same time, assessment selections in accordance with the national exam structure are given priority and the autonomy that is not present in the school causes the loss of the autonomy of the teacher.

Moreover, teachers stated that they needed training for interdisciplinary practices, but they also underlined that they did not receive any in-service training in their schools. Document analysis shows that public schools are given priority in the workshops carried out by MoNE in cities and provinces for conducting of interdisciplinary studies. For example, in the last statement made by MoNE, it was announced that STEM education will be given only to teachers in public science high schools in cooperation with Harvard University (URL 4, 2021). At the same time, in some public schools in certain provinces, STEM projects are carried out in cooperation with Europe. In summary, public schools and teachers working in such schools participate in government's in-service trainings and projects. In this regard, prerequisites such as providing and preparing an appropriate environment for teachers to carry out interdisciplinary studies in private schools and offering necessary training to private school teachers should be enabled without government support.

Lastly, according to the teacher opinions, the lack of subject connections in the curricula has been shown as one of the factors in the non-use of interdisciplinary approach. There are studies in the literature that support this view. The inconsistencies in the subject order of the participating disciplines in the MoNE curricula can negatively affect the interdisciplinary study (Özaydınlı & Kılıç, 2019; Güneş, 2007;

Yolcu, 2013; Sağdıç & Demirkaya, 2014). Literature also shows that, teachers may devise their own strategy for integrating curriculums too (Gürkan & Gökçe, 1999 as cited in Sağdıç & Demirkaya, 2014).

5.1.2. Benefits of interdisciplinary studies

The contributions of interdisciplinary studies to both teachers and students are great. In the interviews, teachers have expressed opinions that interdisciplinary studies not only provide information about different disciplines but also enable teachers to look at their own discipline from different perspectives, and increase communication between teachers. The satisfaction of learning and applying something new professionally and seeing positive results for students is also mentioned. In other studies, it is found that during the planning and implementation of interdisciplinary studies, collaboration of teachers increases the dynamics, maintains professional development, increases interdisciplinary and disciplinary knowledge, and enables teachers to experience professional satisfaction more (Ceran & Gülten, 2017).

According to the findings, teachers think that an interdisciplinary study will contribute greatly to the development of students' 21st century skills. They think that students can reveal their creative, knowledge-creating, innovative and designer aspects, strengthen their problem-solving and critical thinking skills, and develop both effective oral and written communication and leadership skills by means of group work. This finding coincides with this finding in the literature. Many research studies examining the opinions of teachers and students in pilot studies on interdisciplinarity in schools stated that interdisciplinary studies provide cognitive and affective development in students, develop 21st century skills and support their interest in the lesson (Barak & Assal, 2018; Bilekyiğit, 2018; Ceylan, 2014; Drake & Reid, 2018).

Moreover, teachers are of the opinion that students who are successful in different disciplines would obtain motivation by participating in an interdisciplinary project that would both contribute to the project related to their area of interest and throughout the process, strengthen the area in which they are weak. Gardner (2013) also thinks that the theory of multiple intelligence has two important applications in education: individualization (personalization) and pluralization. According to Gardner, while teaching or mentoring, it should be considered that students are unique, it should be

ensured that they increase and reveal their knowledge with appropriate methods, and that every discipline is not the same for every student and various techniques should be utilized while teaching. In the literature, it has been observed that students who take part in interdisciplinary projects develop themselves in different fields and have a learning process in their fields of interest and ability (Demirel, Tuncel, Demirhan & Demir, 2008).

5.2. Implications for Practice

The reason for choosing a private school as a case in this study is the expectation that private schools are more autonomous than public schools and that they can easily implement interdisciplinary studies because they have a more advantageous student group, better technological infrastructure, more financial resources, more course materials, less teacher shortage, better physical conditions, and less crowded class size than public schools. However, the findings revealed that interdisciplinary studies were not implemented in this school and teachers needed training in this regard.

Although MoNE recommends the implementation of methods such as interdisciplinary practices that will prepare students for the changing world and future professions, in the teachers' views, it has been concluded that MoNE curricula and national exams do not allow this to be implemented, and for this reason, several suggestions were made for more effective implementation of interdisciplinary studies at secondary school level in Turkey. First of all, teacher training institutions should include interdisciplinary teaching in their programs and these should be supported by relevant institutions. In-service training should be given to teachers in order to popularize the use of other methods such as interdisciplinary studies that increase the awareness and motivation of students, and differentiated student-centered measurement and evaluation methods apart from classical measurement and evaluation methods.

It should be adopted that the main purpose of an educational institution is not only to prepare students for the national exam, but to train them as a world citizen with 21st century skills. MoNE policymakers, school administrators and practitioners must be certain that institutions value this while applying their curriculum and adopt this culture to their teachers. In this regard, it is recommended to take following steps:

- Science and Math curricula should be arranged to complement each other and by integrating these fields, subjects suitable for interdisciplinary education should be included.
- Teaching materials for interdisciplinary education should be developed along with the evaluation systems that measure both the teacher's in-service training and the teacher's interdisciplinary competence.
- Since national exams are discipline-based exams and schools provide training on the basis of disciplines for national exams, it can be recommended to change the content of the curriculum and reduce the intensity of the content so that interdisciplinary projects are integrated into the lessons and not a club activity with only willing students. By this way, during the school period teachers and students can create time to carry out interdisciplinary projects.
- For the teacher to cooperate with other teachers and for applications such as interdisciplinary projects where the preparation takes time and group dynamics are important, teachers' extra class hours should be reduced and their time needs should be met during working hours in order to create projects.
- National competitions should be organized to increase the motivation of students and teachers, in which not only disciplinary but also interdisciplinary projects can participate.
- Parents should be informed about the processes of applications such as interdisciplinary projects and their contributions to students, apart from standard assessment and evaluation tools such as test-solving.

5.3. Implications for Further Research

This study was designed as a qualitative study with chemistry, biology, physics and mathematics teachers of a private school in Ankara. For future studies, other branches and other schools can be included to study the views of teachers, students, parents and administrators qualitatively and/or quantitatively.

In their opinions, the teachers mentioned that they do not know how to evaluate interdisciplinary practices as formal assessment and evaluation grades and noted that this process would be difficult. In the literature, it has been seen that the studies in which interdisciplinary applications are tried in schools are not graded because they

are pilot and sample studies, and there are not many studies in Turkey on how to assess these studies. Studies can be conducted on how to formally assess interdisciplinary projects.

There are comments on the difference between the official curriculum and the implemented curriculum, on the fact that the subjects that are not in the new curriculum are still taught as in the old curriculum and they take time. It is also mentioned that instead of using the new exam system and question types, excessive and unnecessary information are given to the students by going over both the new and the old exam systems, by stressing the teachers' distrust in the exam system. Researches can be conducted on why there is a difference between the official curriculum and the implemented curriculum, as well as its benefits and harms.

With a longer-term research, the contribution of the interdisciplinary education received at the secondary school and at the university in Turkey to the student's future success in business life and its effect on profession selection can be investigated.

It should also be noted that the researcher is also an employee of the school chosen as the case study in this research, and therefore the researcher has been working with the people participating in the research for a long time, and this situation may represent a limitation to the study. For this reason, future studies can be done with an external research team in order to obtain more reliable results.

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APPENDICES

A. INFORMED CONSENT FORM

ORTA DOĞU TEKNİK ÜNİVERSİTESİ

BİLGİLENDİRİLMİŞ GÖNÜLLÜ ONAM FORMU

Sizi Eğitim Programları ve Öğretimi yüksek lisans öğrencisi Elif Kara tarafından yürütülen “Öğretmenlerin Bakış Açısıyla Disiplinler Arası Yaklaşımın Lise Fen ve Matematik Derslerinde Uygulanabilirliği” başlıklı araştırmaya davet ediyoruz. Bu araştırmanın amacı lise düzeyinde fen (fizik, kimya ve biyoloji) ve matematik branşları arasında disiplinler arası bir çalışma yapılıp yapılmadığını aşamasında karşılaşılan sorunları veya yapılmama nedenlerini öğretmenlerin bakış açılarına göre araştırmaktır. Bu çalışmanın, disiplinler arası bir çalışmanın lise düzeyinde eğitim programlarımıza entegresinde çıkabilecek problemlerin bilinmesi ve bununla birlikte gerekli çözümlerin sunulması ve tedbirlerin alınması ile öğretmenlerimize yol göstereceğine inanılmaktadır. Araştırmada kapsamında 17 soru bulunan bireysel görüşmeler yapılacaktır ve sizden tahminen 30-45 dakikanızı ayırmanız istenmektedir. Araştırmaya sizin dışınızda tahminen 15 kişi katılacaktır. Bu çalışmaya katılmak tamamen **gönüllülük** esasına dayanmaktadır. Çalışmanın amacına ulaşması için sizden beklenen, bütün soruları eksiksiz, kimsenin baskısı veya telkini altında olmadan, size en uygun gelen cevapları içtenlikle verecek şekilde cevaplamanızdır. Bu formu okuyup onaylamanız, araştırmaya katılmayı kabul ettiğiniz anlamına gelecektir. Ancak, çalışmaya katılmama veya katıldıktan sonra herhangi bir anda çalışmayı bırakma hakkına da sahiptir. Bu çalışmadan elde edilecek bilgiler tamamen araştırma amacı ile kullanılacak olup kişisel bilgileriniz **gizli tutulacaktır**; ancak verileriniz yayın amacı ile kullanılabilir. Eğer araştırmanın amacı ile ilgili verilen bu bilgiler dışında şimdi veya sonra daha fazla bilgiye ihtiyaç duyarsanız araştırmacıya şimdi sorabilir veya elifkara.boun@gmail.com e-posta adresi ve 05342946838 numaralı telefondan

ulaşabilirsiniz. Araştırma tamamlandığında genel/size özel sonuçların sizinle paylaşılmasını istiyorsanız lütfen araştırmacıya iletiniz.

Yukarıda yer alan ve araştırmadan önce katılımcıya verilmesi gereken bilgileri okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları anladım. Çalışma hakkında yazılı ve sözlü açıklama aşağıda adı belirtilen araştırmacı tarafından yapıldı. Bana, çalışmanın muhtemel riskleri ve faydaları sözlü olarak da anlatıldı. Kişisel bilgilerimin özenle korunacağı konusunda yeterli güven verildi.

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve telkin olmaksızın katılmayı kabul ediyorum.

Katılımcının

Adı Soyadı:.....

İmzası:

İletişim Bilgileri: e-posta:

Telefon:

Araştırmacının

Adı-Soyadı:.....

İmzası:

B. TEACHER INTERVIEW

ÖĞRETMEN GÖRÜŞME FORMU

Görüşülen Kişi:

Tarih:

Saat (Başlangıç ve Bitiş):

Değerli Öğretmenim,

Ben Elif Kara. ODTÜ Eğitim Bilimleri Bölümü'nde yüksek lisans öğrencisiyim. Tezimde lise düzeyinde disiplinler arası bir çalışma yapmanın yararlarını, zorluklarını ve çalışmada görev alanların hazır bulunuşluk düzeylerini araştırmaktayım. Aynı zamanda bu çalışmanın, disiplinler arası bir eğitimin lise düzeyindeki eğitim programlarımıza entegresinde karşılaşılabilecek problemlerin tespit edilmesi ve bununla birlikte gerekli çözümlerin sunulması ile diğer öğretmenlerimize de yol gösterebileceğine inanmaktayım. Bu kapsamda fizik, kimya, biyoloji ve matematik öğretmenleri ile görüşmeler yapmaktayım. Bu konuda soracağım sorular ile sizin görüşlerinizi almak istiyorum.

Bu görüşme sırasında paylaşacağınız tüm bilgiler yalnızca bilimsel amaçlar doğrultusunda kullanılacak ve kimliğiniz araştırmacı tarafından gizli tutulacaktır. Görüşme soruları kişisel rahatsızlık verecek sorular içermemektedir. Ancak görüşme sırasında sorulardan ya da başka bir nedenden dolayı kendinizi rahatsız hissederseniz görüşmeyi yarıda bırakabilirsiniz. Eğer kabul ederseniz herhangi bir noktayı kaçırmamak için görüşmeyi kaydetmek istiyorum. Görüşme yaklaşık 25-35 dakika sürecektir.

Görüşmeye başlamadan önce araştırma hakkında sormak istediğiniz bir soru veya sorular varsa memnuniyetle cevap verebilirim. Vakit ayırarak görüşlerinizi paylaştığınız ve katkılarınız için şimdiden çok teşekkür ederim.

Elif Kara

ODTÜ GVO Özel Ankara Lisesi, Fizik Öğretmeni

Orta Doğu Teknik Üniversitesi

Eğitim Bilimleri Bölümü

Eğitim Programları ve Öğretim

İletişim: ekara@odtugvo.k12.tr

FİZİK, KİMYA, BİYOLOJİ VE MATEMATİK ÖĞRETMENLERİ GÖRÜŞME SORULARI

Bölüm 1. Demografik/Kişisel Bilgiler

1. Cinsiyetiniz:
2. Yaşınız?
3. Kısaca eğitim geçmişinizden bahsedebilir misiniz?
 - 3.1. Hangi üniversiteden kaç yılında mezun oldunuz?
 - 3.2. Lisans derecenizi hangi bölümden aldınız? Yan alanınız var mı?
 - 3.3. En son aldığınız eğitim dereceniz nedir? Yüksek lisans ve/veya doktora eğitiminiz varsa alanları nelerdir?
4. Kaç yıldır öğretmenlik yapıyorsunuz? Bugüne kadar hangi okullarda görev yaptınız (devlet, özel vb.)?

Bölüm 2. Görüşme Soruları

5. Farklı okullarda çalıştınız mı? Çalıştıysanız deneyimlerinizden kısaca bahsedebilir misiniz (örneğin uyguladığınız eğitim programı içerikleri gibi)?
6. Disiplinler arası eğitim programları konusunda lisans eğitiminizde veya kurum içi-dışı bir eğitime katıldınız mı? Katıldıysanız içeriği hakkında bilgi verebilir misiniz?
7. Disiplinler arası bir çalışmada daha önce bulundunuz mu?
 - 7.1. Cevabınız evet ise sayısı ve içerikleri hakkında detay verebilir misiniz?
 - 7.2. Hayır ise disiplinler arası program yapıları hakkında neler söyleyebilirsiniz? Neden disiplinler arası bir çalışmada yer almadığınızı belirtebilir misiniz?
8. Disiplinler arası bir çalışmanın öğrenciye katkılarının neler olduğunu düşünüyorsunuz?

9. Sizce disiplinler arası bir çalışma öğrencilerin 21. yüzyıl becerilerini ne düzeyde etkilemektedir? Nasıl?
10. Lise düzeyinde disiplinler arası çalışmalara öğrenciler, veliler ve okul yönetimi nasıl yaklaşıyor, bu konuda neler söylemek isterdiniz? Bir değerlendirme yapabilir misiniz?
11. Sizce lise düzeyinde disiplinler arası bir çalışmanın yapılabilmesi için neler gereklidir?
12. Disiplinler arası bir çalışmada yer almak isteseydiniz, karşılaşacağınız zorlukların neler olduğunu düşünürdünüz?
13. Lise düzeyinde disiplinler arası bir çalışma yapılmasının önündeki engeller sizce neler olabilir?
14. Disiplinler arası eğitim programları hakkında eğitim fakülteleri lisans eğitimlerinin yeterliliğini ne düzeyde buluyorsunuz?
15. Disiplinler arası eğitim uygulamaları hakkında bir eğitim almak isteseydiniz nasıl bir eğitim tasarlanmasını beklerdiniz?
16. Alanınızı diğer hangi alan veya alanlar ile disiplinler arası bir çalışma yapma açısından daha uygun buluyorsunuz? Nedeninizi açıklayınız.
17. Bunların dışında söylemek veya ilave etmek istediğiniz bir şey var mı?

Ayırdığınız zaman ve paylaştığınız bilgi ve görüşleriniz için teşekkür ediyorum. Görüşmemiz sona ermiştir.

C. CODING LIST

Requirements of the interdisciplinary education

- School
 - ✓ School culture
 - ✓ Study environment
 - ✓ Resources
- Readiness
 - ✓ Teacher readiness
 - ✓ Student readiness
- Content
 - ✓ Balanced of disciplinary and interdisciplinary
 - ✓ MoNE curricula
 - ✓ Sequence of subjects
 - ✓ Links between disciplines
- Roles
 - ✓ Teacher
 - Guide/facilitator
 - Planner
 - Givers of disciplinary knowledge
 - Learner
 - ✓ Student
 - Active learner
 - Social interaction
 - Adaption of skills
 - Reflective
 - ✓ Parents
 - ✓ School
- Assessment
 - ✓ Pre-test
 - ✓ Post-test
 - ✓ Presentation
 - ✓ Competition
 - ✓ Peer assesment
 - ✓ Self-assesment
 - ✓ Discussion
- Elements of implementation
 - ✓ Components
 - Integration of experiences

- Social integration
- Integration of knowledge
- Integration of curriculum design
- ✓ Interaction
 - From student to teacher
 - From teacher to student
 - From student to student
 - From teacher to teacher
- ✓ Pleasure of stakeholders
 - Administrators
 - Teachers
 - Students
 - Parents

Restrictions of the interdisciplinary education

- Restrictions
 - ✓ MONE Curriculum
 - Flexibility
 - Interdisciplinary links
 - ✓ Time
 - ✓ Money
 - ✓ Motivation
 - ✓ Education
 - Readiness of teacher
 - Readiness of the students
 - ✓ School
 - School culture
 - School environment
 - Sources
 - ✓ Prejudice
 - ✓ Misconception
 - ✓ Continuity
 - ✓ Group dynamics
 - ✓ Work load (teacher)
 - ✓ Cognitive level of students

Benefits of interdisciplinary approach or teaching

- Aims to develop
 - ✓ Teacher
 - Life-long learner
 - Self-education
 - Disciplinary experting
 - Interdisciplinary knowledge integration

- Analytical thinking
- Cooperation
- Reflective
- Communication
- Open minded
- ✓ Student
 - Mathematical literacy
 - Critical thinkers
 - Analytical thinking
 - Self-education
 - Cooperation
 - Open minded
 - Inquiry
 - Communication
 - Thinkers
 - Adaptation of skills
 - Improvement of multiple-intelligence
 - Self-awareness
 - Appreciation
 - Rational
 - Solution oriented
 - Process oriented

Education of teachers

- Content
 - ✓ Theory
 - ✓ Examples of plan
 - ✓ Benefits for motivation
 - ✓ Workshops
- Long period of time
- In-service training
- Real applications with students

D. AN EXAMPLE OF CODED/ LABELLED INTERVIEW SCRIPT

Date:26.06.2019

Place: Meeting room in the highschool

Interview & Notes	Comments & Codes
<p>Görüşme 26 Haziran 2019 tarihinde okulda bulunan toplantı salonunda başladı. Görüşme öncesinde görüşmenin kayda alınmasının bir sakıncası olup olmadığı soruldu. Görüşme toplamda 28 dk sürdü.</p> <p>R: Sizce disiplinler arası bir çalışmanın yapılabilmesi için neler gerekli?</p> <p>Bence en önemlisi aslında insanın temel ihtiyaçlarından olan şey bir kere alan, yani atmosferin buna çok uygun olması lazım. Fiziksel özellikler. Çünkü bir sınıf ortamında bunu çok yapamazsınız mesela çocuklara bir şey tasarla diyorsunuz ama bulunduğunuz ortam size 12 m² falan bir şey yani orada 24 tane öğrencinin hiçbirinin alanını daraltmadan çalışabilmesi mümkün değil. En önemlisi atölyeler bence.</p> <p>Onun dışında kaynakların yeterli sunulması diye düşünüyorum hani öyle bir şey var tutup bunu yapın diyemezsiniz. Önce çocuğun onu anlaması lazım. Kaynak yeterliliği olabilir. Bunda tabi öğretmenin donanımı da bir kaynak aslında yani hiç bilmeyen bir öğretmen çıkıp da bir şey yapamaz. Ortamdan sonra kaynak yeterliliği diye düşünüyorum.</p> <p>Üçüncüsü motivasyon. Çünkü motivasyon ruhun gıdası olan o temel ihtiyaçlardan bence. Çocuğunun motive olması için öğretmenin de gerçekten hevesli olması lazım yani siz hadi böyle bir şey var yapıverin dersiniz çocuk da yapıverir yani güzel olmaz diye düşünüyorum.</p>	<p><i>-Environment</i></p> <p><i>-Physical conditions</i></p> <p><i>-Classroom not enough</i></p> <p><i>-Labs</i></p> <p><i>-Sources</i></p> <p><i>-Student readiness</i></p> <p><i>-Teacher readiness</i></p> <p><i>-Student motivation</i></p> <p><i>-Teacher motivation</i></p>

E. METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER



ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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Sayı: 28620816 / 487

12 EYLÜL 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof.Dr. Ahmet OK

Danışmanlığını yaptığımız yüksek lisans öğrencisi Elif KARA'nın "**Öğretmenlerin Bakış Açısıyla Disiplinler Arası Yaklaşımın Lise Fen ve Matematik Derslerinde Uygulanabilirliği**" başlıklı araştırmanız İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-EGT-130** protokol numarası ile **12.09.2018 - 31.08.2019** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN

Başkan V

Prof. Dr. Ayhan SOL

Üye

Prof. Dr. Ayhan Gürbüz DEMİR

Üye

Doç. Dr. Yaşar KONDAKÇI

Üye

Doç. Dr. Zana ÇITAK

Üye

Doç. Dr. Emre SELÇUK

Üye

Dr. Öğr. Üyesi Pınar KAYGAN

Üye

F. TURKISH SUMMARY/TÜRKÇE ÖZET

BÖLÜM 1 & 2

GİRİŞ VE İLGİLİ ALAN YAZIN

Sosyal, ekonomik, teknolojik ve politik açılardan gelişen ve değişen bir dünyanın içerisinde yaşanılmaktadır. Bu durum dünyadaki bir çok sistemin dengesini de değiştirmektedir. Teknolojinin ilerlemesi ve bilgiye ulaşımın kolaylaşması ile de globalleşen ve yenilikçiliğin çok önemli olduğu bir sisteme geçiş olmaktadır (Roberts & Owen, 2012). Eğitimin ana amacı ise öğrencileri bu değişen ve gelişen gerçek yaşama hazırlamasıdır yani bilgiyi ezberleyen bireyler değil değişime uyum sağlayabilen, bilgiye nasıl ulaşacağını öğrenen, problem çözebilen, yaratıcı bireyler yetiştirmelidir (Aybek, 2006). Bu da demektir ki eğitim sistemi de bu değişen dünya ile birlikte gelişmeli değişmeli ve ihtiyaçlara cevap verecek şekilde evrimleşip ideal bir hal almalıdır ve ideal bir eğitim programının da sadece akademik disiplinlerin ve kültürel değerlerin aktarımına göre değil aynı zamanda öğrencilerin ilgi ve ihtiyaçlarına göre oluşması gerekmektedir (Dewey, 2008). 21 yüzyılda ise hem öğrenci ihtiyaçlarının, hem öğrenci profilinin değiştiği görülmektedir. Bireylerin yaşamlarını sürdürebilmeleri, hayata uyum sağlayabilmeleri ve iş hayatında başarılı olabilmeleri için gereken becerilerin günümüzde değiştiği üzerine bir çok çalışma bulunmakta ve eğitim sistemlerinin bu becerileri kazandırması gerekliliği üzerinde durulmaktadır (Partnership for 21st Century Skills, 2009; OECD, 2018). Özetle bu beceriler öğrencilerin sadece okul yaşamında gelişimini değil, kendini geliştirebilen ve değişimlere uyum sağlayabilen bilişsel, davranışsal ve duygusal bir uzmanlık gelişimini ifade etmektedir (Cansoy, 2018). Türkiye eğitim sisteminde de eğitim programları uygulamaları sorgulayıcı bir bakış açısı geliştiremediği, ezberci, günlük hayatla ilişkili olmayan ve öğretmen merkezli oldukları sebebiyle eleştirilmiş bu amaçla da eğitim programlarında 2005 senesinde köklü bir değişime gidilmiş ve 2016 senesini takiben programlar genel olarak tamamlanmıştır (Özdemir, 2005). Yeni eğitim programlarında da Milli Eğitim Bakanlığı tarafından 21. Yüzyıl becerilerinin önemi vurgulanmış ve bu beceri ve tutumlar bütün programların içerisinde hedeflenen

“Türkiye Yeterlilikler Çerçevesi” başlığı altında 8 maddede sıralanmıştır (Talim ve Terbiye, 2017). Milli Eğitim Bakanlığı da (2018) bu eğitim programlarının uygulanması bu beceri ve yeterliliklerin öğrencilere kazandırılmasında eğitim programların içeriğinden çok öğretmenin programları uygularken seçeceği özgün ve yaratıcı ölçme ve değerlendirme araçlarının öneminden bahsetmiştir. Özetle hem bireyler hem de toplumların refah düzeyi için 21. Yy becerilerinin kazandırılmasının çok önemli bir hale geldiği eğitim sistemlerinde artık öğretmen merkezli yöntemlerle kalıplaşmış bilgileri öğrenciye sunmak yerine öğrenci merkezli yöntemler kullanılması ve değerlendirme uygulamalarında klasik, standart yöntemlerden vazgeçilmesi gerekliliği, vurgulanılmaktadır (Sawyer, 2008). Öğrenci merkezli dizayna sahip olan disiplinlerarası uygulamalar da günümüzde hem 21. Yy becerilerini geliştirdiği hem de gerçek hayattaki problemlerin çözümlerine yönelik öğrenciyi parçaları değil bütünü görmeyi ve algılamayı öğrettiği için önem kazanmaktadır (Cowden & Santiago, 2016; Jacobs 1989; Perkins, 1994).

Disiplinler arasındaki ilişkiyi öğrenci ihtiyaçlarına göre şekillendirmeye çalışan disiplinlerarası eğitimi, Yıldırım (1996) problem veya konu gibi belirli bir kavram temel alınarak, bu kavramı aydınlatabilecek disiplinler bilgi ve becerilerin bütünleştirilmesi olarak açıklarken Jacobs (1989) ise bu yaklaşımı bir kavramın, konunun, problemin ya da tecrübenin incelenmesinde iki veya daha fazla disiplinin bilgi ve yöntemlerini bilinçli bir biçimde kullanması olarak tanımlamaktadır. Wiggins (2001, as cited in Baker, 2007) gerçek hayatın konu konu ayırlamayacağını, gerçek hayata hazırlayan okulların da hayattan kopuk olamayacağını belirtmektedir. Ancak literatür göstermektedir ki olumlu yanları ispatlanan bu uygulamaların eğitim sistemimiz içerisindeki yeri hala kısıtlıdır ve çoğunlukla da öğrenci merkezli uygulamalar yerine klasikleşmiş öğretmen merkezli uygulamalara ve ders işlenişlerine devam edilmektedir (Örücü, 2014; Yeşil & Şahan, 2015). Özetle eğitim sistemimizin öğrenci ilgi ve becerilerinden uzak bir şekilde ve global dünyaya hazırlanması açısından gerekli becerileri kazandırmada geri kalarak işleyişini sürdürmektedir.

Disiplinlerarası çalışmaların neden formal eğitime yedirilemediği araştırıldığında öncelikle öğretmenin bu konuda eğitimi olmaması sebebiyle motivasyonunun da olmaması, öğretmenlerin bir araya gelecek ortamı sağlayamaması, öğretmenlerin diğer eğitim programları hakkında bilgisi olmayışı (Ayvacı, 2010; Coşkun, 2013; Yolcu,

2013), öğrencilerin hazırbulunuşluk seviyelerinin düşük olması (Al Salami, Miranda & Makela, 2017) gibi sebepler ile karşılaşılmaktadır. Ayrıca Milli Eğitim Bakanlığı eğitim programlarında da konu sıralamalarındaki uyumsuzluklar da çalışmayı olumsuz etkileyebilmektedir (Özaydınlı & Kılıç, 2019).

BÖLÜM 3

YÖNTEM

Bu araştırma, disiplinlerarası çalışmaların lise düzeyinde fen ve matematik alanlarında eğitime entegre edilmesinin uygulanabilirliğini ve bu çalışmaların eğitim sistemine entegrasyonun önündeki olası engelleri tartışmayı amaçlamaktadır.

Araştırma soruları bu amaçla aşağıdaki gibi düzenlenmiştir:

1. Disiplinlerarası yaklaşımın lise fen ve matematik eğitiminde uygulanabilirliği nedir?
2. Disiplinlerarası yaklaşımın lise fen ve matematik eğitiminde fen ve matematik öğretmenlerinin bakış açısıyla uygulanmasını gereksinimleri, yararları ve kısıtlamaları açısından hangi faktörler etkiler?
3. Disiplinler arası yaklaşımın öğretmen eğitimine ilişkin fen ve matematik öğretmenlerinin görüşleri nelerdir?

Araştırmanın genel deseni olarak nitel araştırma desenlerinden durum çalışması olarak kurgulanmıştır. Durum olarak özel bir lise seçilmiş ve bu okulda da sadece fizik, kimya, biyoloji ve matematik alanlarında disiplinlerarası çalışmaların yapılabilirliği araştırılmıştır. Araştırmada veri toplamak amacı ile döküman analizi, yapılandırılmamış gözlem yapılmış ve yarı yapılandırılmış görüşme dizayn edilmiştir (triangulation).

Döküman analizinde 2018 yılında güncellenmiş MEB Fizik, Kimya, Biyoloji ve Matematik eğitim programları detaylı bir şekilde incelenmiş ve karşılaştırılmıştır. Ayrıca fen ve matematik bölümlerinde kullanılan performans ve ödev kağıtları incelenmiştir. Yapılandırılmamış gözlemlerde ise fizik, kimya, biyoloji ve matematik dersleri ve okul atmosferi, okulda yapılan kulüpler ve diğer sosyal aktiviteler gözlemlenmiştir.

Yarı yapılandırılmış görüşme soruları ise iki bölümden oluşmaktadır. Birinci bölümde demografik bilgiler; ikinci bölümde ise disiplinlerarası çalışmaların lise fen ve matematik alanlarında yapılabilirliği, uygulanma öncesi veya uygulanma esnasında oluşabilecek engeller, öğretmen ve öğrenci hazırbulunuşlukları ile disiplinlerarası eğitimin yararları sorulmuştur. Görüşmeye özel bir lisede çalışan 13 öğretmen katılmıştır. Bu öğretmenlerin 3'ü fizik öğretmeni; 3'ü kimya öğretmeni, 3'ü biyoloji ve 4'ü de matematik öğretmenidir. Görüşme öncesi pilot çalışması yapılmış ve pilot çalışmasında fizik, kimya, biyoloji ve matematik alanlarında görev yapan 12. sınıf öğretmenleri seçilmiştir. Bu durumun sebebi 12. Sınıfa giren öğretmenlerin tamamen klasik yöntemler ile ders işleme, alt seviye gruplarına girmemesi ve sadece ulusal sınava yönelik çalışma yaptıkları içindir. Fen ve matematik bölümlerindeki diğer bütün öğretmenler çalışmaya katılmışlardır. Bu öğretmenlere fen ve matematik alanlarının zümre başkanları da dahildir. Görüşme soruları son halini alırken bir ölçme değerlendirme uzmanı ve müfredat geliştirme uzmanı ve akademisyen soruları değerlendirmiştir. Görüşmeler ortak toplantı salonu veya öğretmenlerin lablarında birebir gerçekleştirilmiş ve görüşme öncesi öğretmenden gerekli izinler alınarak görüşmeler kaydedilmiştir. Kaydedilen görüşmeler kağıda dökülerek metin hale getirilmiştir. Metinler araştırmacı tarafından öncelikle birçok kez dinlenilmiş, devamında ise araştırmacı ile meslektaş başka bir araştırmacı tarafından da dinlenilerek bulgular karşılaştırılıp, yorumlanmıştır. Bu şekilde kodlama işlemi yapılırken metinler tekrar iki ayrı katılımcıya sunulup istenilen anlamı taşıyıp taşımadığı üzerine katılımcılardan doğrulama alınmıştır. Kodlamalar belirli temalar etrafında bir araya getirildikten sonra araştırma sonuçları öğretmenlere takma isimler verilerek yazılmıştır. Araştırmada veriler toplanmadan önce görüşme sorularının geçerliliği ve güvenilirliği açılarından üniversite etik kurulu ve durum olarak seçilen özel okuldan gerekli izinler alınmıştır.

Çalışmanın bir durum çalışması olması sebebi ile sonuçların başka durumlara da genellenebilirliği sınırlıdır.

BÖLÜM 4

BULGULAR

Öğretmen görüşlerine göre disiplinlerarası bir çalışmanın yapılabilmesi ve eğitim programlarının içine yedirilebilmesinde okul kültürü, uygulamanın içeriği ve eğitim programına uygunluğu, kaynakların yeterliliği ve uygun fiziksel ortamın sağlanması, öğretmen ve öğrenci hazırbulunuşluğu gibi bir çok faktör önemli bir rol oynamaktadır.

Öğretmenler tarafından disiplinlerarası bir çalışma yapılabilmesi için en önemli kriterlerden birinin okul kültürü olduğu vurgulanmıştır. Eğer okul, öğrenciye sadece test çözdürterek üniversite sınavlarına hazırlama ve sadece üniversite sınavlarındaki başarısı ile de anılma şeklinde bir kültüre sahipse disiplinlerarası çalışmalar gereksiz ve zaman kaybı olarak görülebilmekte, en başta okul yönetimi bu tür proje ve eğitim programlarına karşı çıkacağından ve de okulun eğitim tarzını bilen bir veli ve öğrencinin de bu çalışmalara olumlu bakmayacağından öğretmen de bu kültürü benimseyecek ve disiplinler eğitimi sınırlarında kalmayı tercih edecektir. Disiplinlerarası bir eğitimin gerekliliği için daha esnek ve yeniliklere açık bir yönetim, birbiri ile etkileşimi yüksek departmanlar, sonuçtan ziyade öğrenme sürecine de önem veren ve müfredatta esnekliğe ve yeniliklere açık bir okul kültürünün gerekliliği öğretmen görüşlerinde vurgulanmıştır.

Disiplinlerarası bir program ya da projenin tasarlanması için seviyesi, içeriği ve belirlenen seviyeye göre uygulanmak istenen sınıf seviyesi önem taşımaktadır. Öğretmenler görüşlerinde, lisede disiplinlerarası yapılan projelerde kazanımların çok düşük kaldığını belirtmişlerdir. Bunun sebebini iki şekilde açıklamaktadırlar. Birincisi seviye olarak daha çok 9 ve 10. sınıf öğrencilerinin disiplinlerarası projelere dahil olması ancak bu seviye öğrencilerin de daha alanlaşmadıkları için bilgi birikimlerinin her disiplinde ileri bir seviyede olmaması, ikincisi ise disiplinlerin eğitim programlarının da birbiri ile uyumlu olmaması sebebi ile 9. ve 10. Sınıf eğitim programlarının ortak buluşabileceği konuların azlığı olarak gösterilmiştir. Bu nedenlerle disiplinlerarası bir projenin zaman, harcanan emek ve gerçekten amacına ulaşabilmesi için kazanımlarının ve uygulanacak seviyelerin çok iyi belirlenmesi gerektiği vurgulanmıştır. Tek bir öğretmenin tek bir disiplini baz alarak diğer disiplinleri zorla entegre etmeye çalışması yerine, proje fikrinin oluşması ve gelişmesi

için ve projenin uygulanabilirliği açısından öğretmenlerin bir araya gelerek çalışma yapmaları, proje içeriğini ve bu içeriğe uygun öğrenci seviyesini belirlemeleri, proje süresince ve sonunda elde edilmek istenen kazanımları detaylı bir şekilde raporlamaları, bir zaman çizelgesi ve öğrenciler için detaylı bir rubrik hazırlamalarının gerekliliği üzerinde durulmuştur.

Öğretmenler görüşlerinde disiplinlerarası çalışmaların yapılabilmesi için okuldaki kaynakların yeterli olması ve okulda hem öğretmenler hem de öğrenciler için ayrıca toplantı yapılacak odaların ve çalışma yapılacak laboratuvarların bulunması gerekliliğini vurgulamışlardır.

Disiplinlerarası bir program içeriklerinin hazırlanması için öğrenci ve öğretmen hazırbulunuşluğu da önem taşımaktadır. Öğretmen görüşlerine göre, bir öğretmenin disiplinlerarası çalışmaları yapabilmesi için en başta motivasyona ihtiyacı vardır. Öğretmenin motivasyonunu ve en önemlisi ortaya çıkacak olan çalışmanın kalitesini etkileyecek olan etkenlerden birisi de öğretmenin disiplinlerarası çalışmalar için yeterli donanım ve bilgi birikimine sahip olmasıdır. Öğretmenin bu konuda yeterli bilgisi veya tecrübesi yoksa bu konuda iki yol tercih edilebilir. Birincisi okul yönetimi tarafından kurum içi bir eğitim dizayn edilmesi ve öğretmenlerin eğitilmesi, ikincisi ise disiplinlerarası çalışmalar için yeterli tecrübe ve donanıma sahip öğretmenlerden oluşan bir kurulun oluşturulması ve bu kurulun okuldaki yapılacak projelere liderlik etmesidir.

Öğretmen görüşlerine göre disiplinlerarası çalışmaların öğretmen ve öğrencilere katkıları oldukça fazladır. Disiplinlerarası çalışmalar için hazırlanan öğretmenlerin sadece başka alanlarda değil aynı zamanda kendi alanında da daha uzmanlaşmakta diğer disiplinler ile bağlantılarını keşfetmektedir. Öğretmeni gelişime açık tutarak diğer öğretmenler ile olan iş birliğini de artırabilir. Öğretmenler, disiplinlerarası çalışmaların öğrencilerde de iş birliği yapma ve iletişim kurma becerilerini arttıracığı gibi analitik düşünme, kendi öğrenim sürecini deneyimleme, öğrenmeyi öğrenme, kendinin farkına varma, derse karşı ilgisinin artması, adapte olabilme gibi becerilerini de arttırabileceğini düşünmektedirler.

Öğretmen görüşlerine göre disiplinlerarası çalışmaların okulda uygulanmamasının sebebi olarak öğrencilerin ve öğretmenlerin hazırbulunuşluk seviyelerinin düşük

olması, bu tarz uygulamalara karşı motivasyonlarının yüksek olmaması çünkü uygulamaların üniversiteye giriş sınavında öğrencilere bir yardımının dokunmayacağına inanılması, öğretmenlerin ve öğrencilerin ders dışı zamanlarda bir araya gelmeleri ve çalışmaları gerektiği ancak bunun için de zaman bulunamaması ve gerekli koşulların sağlanamaması, disiplinlerarası uygulamaların zaman kaybı olacağına dair oluşmuş önyargılar, disiplinlerarası uygulamaların yapılması için eğitim programları arasında yeterli bağlantıların bulunmaması gibi görüşler bildirilmiştir.

BÖLÜM 5

SONUÇ

Okul içerisinde yapılan data analizi ve gözlemler sonucu görülmüştür ki fen ve matematik alanlarında disiplinlerarası uygulamalar formal eğitimin içerisinde yapılmamaktadır. Literatür de disiplinlerarası uygulamalar üzerine yapılan çalışmaların ve araştırmaların her geçen gün artmasına rağmen Türkiye’de hala sayıca az olduğunu göstermektedir (Turna & Bolat, 2015).

Öğretmen görüşlerinden çıkarılan sonuçlara göre bu durumun sebepleri için lise sonunda öğrencilerin gireceği ulusal sınav, uygulanan eğitim programları, öğretmen ve öğrenci hazırbulunmuşlukları ve öğretmen özerkliği incelenebilir.

Türkiye’deki test merkezli ve disiplinler eğitimin sebebi olarak lisede 12. sınıf sonrası girilen ulusal sınavdır. Ulusal sınavda her dersin ayrı ayrı olması disiplinler eğitimi savunurken, ölçüm tekniğinin sadece test olması da yine okullarda öğrencileri sürekli olarak test çözmeye yönlendirmektedir. Bu da hem öğretmeni ölçme ve değerlendirme araçlarının kullanımı hem de eğitim-öğretimi klasik yöntemler dışında zenginleştirme konularında köreltmektedir (Aksoy, Akgündüz, Demir, Tunacan, Türk & Uğur, 2014). Ayrıca okul yönetimleri de ulusal sınavlardaki başarıları özel okullar için bir değer katkısı olarak görmekte ve bu nedenle de sürekli klasik yöntemler ile ölçme değerlendirme yapılmasının hem öğrenci hem de öğretmene verdiği zararları gözardı etmektedirler (Wall, 2000).

Öğretmenlerin sınıflarında ölçme ve değerlendirme metotlarının seçiminde limitli oluşu da öğretmen özerkliğinin az oluşunu göstermektedir. Bu durum hem öğretmen görüşlerinde belirtilmiştir hem de literatür de Türkiye’de öğretmen ve okul

özerkliklerinin düşük olduđu görüşünü desteklemektedir (OECD, 2018). Ancak bu durum öğrenci özerkliğini ve başarısını da olumsuz etkileyebilmektedir (Pearson & Moomaw, 2005; Yazıcı, 2016).

Disiplinlerarası çalışmaların yapılmamasında bir diđer etken olarak öğretmenler görüşlerinde hazırbulunuşluklarının düşük olduğunu ve disiplinlerarası uygulamalar ile alakalı ne lisans eğitimlerinde ne de hizmetiçi bir eğitime katılmadıklarını belirtmişlerdir. Literatür de bu durumu desteklemektedir. Lisans düzeyinde disiplinlerarası uygulamalar ile ilgili bir ders içeriğine rastlanmamıştır. Ayrıca Milli Eğitim Bakanlığı tarafından düzenlenen eğitimlerde öncelik devlet okullarında çalışan öğretmenlere verilmektedir (URL 4, 2021). Özel okullarda çalışan öğretmenlerin eğitimi için özel okulun bir hizmetiçi eğitim planlaması gerekebilmektedir.

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