CONTENT ANALYSIS OF 9thGRADE PHYSICS CURRICULUM, TEXTBOOK, LESSONS WITH RESPECT TO SCIENCE PROCESS SKILLS

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submitted by **BERİL YILMAZ SENEM** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Secondary Science and Mathematics Education Department, Middle East Technical University** by,

Prof. Dr. Canan Özgen ________
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Ömer Geban ________
Head of Department, **Secondary Science and Mathematics Education**

Assoc. Prof. Dr. Ali Eryılmaz ________
Supervisor, **Secondary Science and Mathematics Edu. Dept., METU**

Examining Committee Members:

Assoc. Prof. Dr. Hünkar Korkmaz ________
Educational Sciences Dept., Akdeniz University

Assoc. Prof. Dr. Ali Eryılmaz ________
Secondary Science and Mathematics Education Dept., METU

Assoc. Prof. Dr. Özgül Yılmaz-Tüzün ________
Elementary Science Education Dept., METU

Assist. Prof. Dr. Ela Ayşe Köksal ________
Elementary Science Education Dept., Niğde University

Assist. Prof. Dr. Ömer Faruk Özdemir ________
Secondary Science and Mathematics Education Dept., METU

Date: 10.09.2013

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

Name, Last Name: Beril Yılmaz Senem

Signature :

ABSTRACT

CONTENT ANALYSIS OF 9th GRADE PHYSICS CURRICULUM, TEXTBOOK, LESSONS WITH RESPECT TO SCIENCE PROCESS SKILLS

YILMAZ SENEM, Beril
Ph.D., Department of Secondary Science and Mathematics Education
Supervisor: Assoc. Dr. Ali ERYILMAZ

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The purpose of this study is to investigate the extent in which science process skills are included in 9th grade physics curriculum (TTKB, 2011), 9th grade physics textbook (MONE, 2010) and 9th grade physics lessons. Moreover, it investigates to what degree the curriculum, the textbook and physics lessons were consistent with the inclusion of science process skills.

A content analysis was conducted to the curriculum, textbook and observation of three physics teachers' lessons. Science Process Skills Questionnaire and Observation Sheet were used to collect data about the physics lessons. Science Process Skills Code Book was constructed for analysis. NVIVO, software for content analysis was used during the data analysis process.

The results showed that the 9th grade physics curriculum emphasizes collecting-interpreting data whereas disregards predicting, experimenting and inferring. This investigation found that 9th grade physics textbook highly includes collecting-interpreting data and measuring however, ignores hypothesizing and defining-controlling variables. The results of content analysis of 9th grade physics lessons in Energy chapter revealed that modeling highly takes place in lessons as use of mathematical equations in expressing the relationships among physical quantities. In contrast, hypothesizing, inferring, defining-controlling variables, experimenting and predicting almost never appear during physics lessons in Energy chapter.

The similarity of the curriculum, textbook and physics lessons is that collecting-interpreting data highly involved in three of them. The physics textbook is parallel to the lessons regarding the levels of skill-based domain. The skill of measuring is involved in knowledge-based domain in all, while others are mainly included in the skill-based domain.

Keywords: Science Process Skills, 9th grade physics curriculum, 9th grade physics textbook

ÖZ

9. SINIF FİZİK PROGRAMI, DERS KİTABI VE DERSİNİN BİLİMSEL SÜREÇ BECERİLERİ YONUNDEN İÇERİK ANALİZİ

YILMAZ SENEM, Beril
Doktora, Ortaöğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Yöneticisi: Doç. Dr. Ali ERYILMAZ

Eylül 2013, 296 sayfa

Bu çalışmanın amacı bilimsel süreç becerilerinin 9. sınıf fizik programı (TTKB, 2011), 9. sınıf fizik ders kitabı (MEB, 2010) ve 9. sınıf fizik derslerinde nasıl ve ne derece yer aldıklarını araştırmaktır. Ayrıca, program, ders kitabı ve fizik derslerinin bilimsel süreç becerileri içerikleri bakımından ne derece tutarlı olduklarını da incelemiştir.

Ders programını, ders kitabını ve üç fizik öğretmeninin ders gözlem kayıtlarını incelemek için içerik analizi uygulanmıştır. Bilimsel süreç becerileri anketi ve gözlem formu fizik dersleri hakkında veri toplamak için kullanılmıştır. Analiz için bilimsel süreç becerileri kod rehberi araştırmacı tarafından geliştirilmiştir. Veri analizi işlemi sırasında içerik analizi için NVIVO yazılım kullanılmıştır.

Sonuçlar 9. sınıf fizik programının veri toplama-yorumlamaya önem verirken, tahmin etme, deney yapma ve çıkarım yapmayı göz ardı ettiğini göstermiştir. Bu araştırmada, 9. sınıf fizik ders kitabının veri toplama-yorumlama ve ölçmeye geniş yer verirken hipotez kurma ve değişkenleri tanımlamayı-kontrol etmeyi göz ardı ettiği belirlenmiştir. 9. sınıf fizik dersi Enerji bölümünün içerik analizi sonuçları, derslerde modelleme becerisine geniş yer verildiğini ancak bu becerinin sadece matematiksel denklemler bazında yer aldığını göstermektedir.

Fizik programı, ders kitabı ve fizik derslerinin benzerliği, üçünde de veri toplama-yorumlamanın en çok içerilen beceri olmasıdır. Fizik dersleri, içerdiği bilimsel süreç becerilerinin kategori boyutunda da kitap ile paraleldir. Diğer taraftan, derslerde ölçme becerisi sadece bilgi boyutunda ele alınmıştır, diğerlerinde beceri boyutunda içerilmiş olmasına rağmen.

Anahtar Kelimeler: Bilimsel Süreç Becerileri, 9. sınıf fizik programı, 9. sınıf fizik ders kitabı

To my father Şerafettin YILMAZ,
My first educator, made me who I am

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LIST OF ABBREVIATIONS

SPSCB	: Science Process Skills Code Book
SPS	: Science Process Skills
BSPS	: Basic Science Process Skills
ISPS	: Integrated Science Process Skills
PTSE	: Physics--Technology- Society-Environment
AV	: Attitudes and Values
PSS	: Problem Solving Skills
ICT	: Information and Communication Technology
SPSOS	: Science Process Skills Observation Sheet
SPSQ	: Science Process Skills Questionnaire
DK	: Declarative Knowledge
PK	: Procedural Knowledge
KB	: Knowledge-Based Domain
SB	: Skill-Based Domain

CHAPTER 1

INTRODUCTION

The knowledge has been collected systematically since the first era. It becomes difficult to follow new concepts and phenomena in science due the rapid change in knowledge and technology. The pursuit of advancements would definitely be slow if scientists of a generation simply learned the facts of earlier generations. It is the product of earlier scientists that the results of investigations about the physical world. Science, on the other hand, is also a method of discovery and learning which creates the collected knowledge. The collected knowledge is important without a shadow of doubt; however, the process of generating knowledge is essential for science which is a continuous and evolving method.

Science is usually defined as a noun; nevertheless it implies an active way or method of obtaining knowledge; asking questions and finding answers systematically. Pollak (1993) defines science as the "study of patterns in nature" (p.157) and argues that scientific knowledge comes eventually from experience; it is not called as science when the knowledge is not rooted in experience. He states that science cannot be considered without process; without process there is always need to go back and start from beginning. Gottlieb (1997) describes science as an intellectual activity carried on by humans that is intended to find out information about the natural world in which humans live and to determine the ways in which this information can be organized into meaningful patterns. A primary aim of science is to collect facts by systematic and organized way.

Science, more than collected knowledge, is a process which should be taken into account in science education. The development of science process skills should be involved in the goals of science education as well as the transmission of science concepts (Rohaida, 2004). Like riding a bike, or playing baseball, a person must be taught to 'do science' from a practical point of view (Kujawinski, 1997). Therefore it is better for students to gain the skills of accessing and analyzing the knowledge besides learning the accumulated scientific facts (Bilgin, 2006; McDermott, 1991).

The ability to question, discover and inquire new ideas which are parts of process skills are critical competencies for the 21st century. Developing these skills in school will lead students to understand the dimensions of actual work of scientists and make meaningful decisions in their life. Science process skills are mainly defined as the processes that scientists use in the processes of doing science. Archimedes, Aristotle, or Galileo, scientists have been constantly looking for answers to the questions about the world around them.

Observing, measuring, calculating, and predicting are some of the processes they use as they design and carry out, reason and communicate about their personal encounter with the universe. Llewellyn and Rajesh (2011) state that students will get into a realistic view of science and improve abilities in reasoning and communication by science process skills.

Many educators have stated that change in science curriculum has become inevitable in today's world in order to meet the needs of society (El-Sheikh Hasan, 2000; Flett & Wallace, 2005). During the twenty-first century, in many parts of the world, a shift has taken place from industrial to technology based societies which also reflects on science education. The teaching of scientific principles which dominated science curricula prior to 1950 has given way, in proposal if not practice, to a greater consideration of scientific process (DeBoer, 1991). Science education is increasingly focusing on the instruction of the processes of science as a valid educational objective.

The major reason in the popularizing of science process skills is the development of the science program Science A Science Process Approach (S-APA). S-APA was the first program that focused on skills that scientist used to solve problems. These process skills are explained as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the true behavior of scientists (Marshall, 1990). In addition, in US, the science curriculum in 2009, emphasizes that the "science education is not just about learning facts in a classroom, it's about doing activities where students put their understanding of science principles into action" (NCES 2012, p.1). Similarly, the National Science Education Standards outlined science as inquiry as the guiding principle for the organization of science education. In doing so, the standards addressed a changing emphasis in science towards promoting scientific inquiry as not only an instructional strategy, but also as an ability to be developed and an idea to be learnt. Therefore, students are now expected to develop their science process skills as well as their understanding of the scientific concepts (NRC, 2000 as cited in Mitchell, 2007).

Curriculum plays a vital role in education; the quality and standards of the curricula promote the quality of education. Countries organize their education programs according to contemporary necessities of time. When a reform takes place in the curriculum, it necessarily affects textbooks, lessons as the implementation of educational program, teachers' lesson plans, assessment tools, etc. are like the domino effect. In the light of this effect, the curriculum has three aspects: the intended curriculum, the implemented curriculum, and the attained curriculum. The intended curriculum is the one prescribed by curriculum developers, the implemented curriculum is the one that is actually performed by teachers in their classrooms, and the attained curriculum is the one gathered by students (Howson & Wilson, 1986). In education, there is frequently a mismatch between the intended, the implemented, and the attained curriculum (Cuban, 1993). According to the changes in intended curriculum other outcomes of curriculum like textbooks, and teaching activities are affected.

Textbooks, the fundamental materials for lessons, are predominantly used by teachers to develop lessons. Most teachers rely on textbooks to define both what and how they teach (Chiappetta, & Fillman, 2007). Having an essential role in reflecting the curriculum in terms of content and objectives, textbooks are important materials to achieve the goals of the curriculum. Therefore, textbooks have a crucial part on achieving the goals of curriculum as a teaching aid (Chieppetta, Fillman, & Sethna, 1991). In this perspective, to serve the purpose of any curriculum, the textbooks written corresponding to the curriculum should be consistent in terms of content, goals and objectives of the curriculum. Given the impact of textbooks on learning, the content of physics textbooks must present science process skills, rather than simply presenting collection of scientific facts.

There are many studies focusing on textbook analysis according to the science process skills (Fuhrmann, Novick, Tamir & Lunetta; as cited in Nieddere, et al. 2002; Germann, Hasking, & Auls, 1996; Soyibo, 1998; Tamir and Lunetta; as cited in Hanauer, Hatfull, Jacob-Sera, 2009). The results of these studies show that the materials analyzed in each study were highly structured and students are seldom asked to formulate a question to be investigated, formulate a hypothesis to be tested, predict experimental results, work according to their own design, and formulate new questions based on investigation they conducted.

The curriculum shows the objectives of the teaching and learning process, and the teacher is the person who should know how to implement these objectives. Therefore, any teaching process ignoring the curriculum fails. Padilla (1990) says that it is possible to improve students' science process skills when these skills are a part of the curriculum, thus teachers should plan classroom activities addressing the process skills. Observing actual classroom activities provides a more complete understanding of the implementation of educational reform and the potential effects of the educational curriculum. The teacher, a bridge between intended and implemented curriculum, is the most significant figure in interaction with students in educational settings. Hence, she/he is directly responsible for attaining the general aims and objectives of the curriculum.

Examination of the curriculum implementation should be taken into consideration especially in the periods when educational reforms take place. Because when these reforms take place, a lot of changes and developments regarding education are expected to happen in the educational settings. In order to be successful in the reforms, teachers should interpret the changes and developments in the right way and reflect these changes into their teaching activities in the classroom.

1.1 Need for the Study

In order to meet today's needs in science education, reform on elementary science curricula was made in Turkey similar to other modern countries by increasing value on science process skills. In order to reflect changes in science, technology and society to the educational system, Ministry of National Education in Turkey made deep-rooted changes. These changes include the development of scientific literacy at the heart of the elementary education curriculum (TTKB, 2005). The curriculum has being implemented at nationwide since the academic year 2004/2005.

One of general aims of the elementary science curriculum is that: All students, regardless of individual differences, should have the opportunity to attain high levels of scientific literacy (TTKB, 2005, p. 5). The seven aspects of scientific literacy emphasized in the curriculum were: Nature of science, key science concepts, scientific process skills, interaction of science-technology-society-environment, scientific and technical psychomotor skills, essential values of science, and attitudes and interests of science. One of essential features of this curriculum is that it aims to develop students' necessary abilities to do science within an investigative framework and to capture perspectives of scientists.

In line with the changes in elementary science curriculum in Turkey, physics curriculum at secondary level as a branch of science needed to be changed. Therefore, a curriculum development process began and was finalized in September, 2007. The vision of the new physics curriculum (TTKB, 2007) was to educate productive students who realize that physics is the life itself and solve problems by using scientific methods (p.11). The important features of the curriculum were being spiral for content development and including objective of skills like problem solving skills, physics-society-technology- environment, informatics and communication skills, and attitudes and values.

At secondary schools, students are expected to decide a branch like mathematics-science, mathematics-social sciences, and social sciences in the end of 9^{th} grade in Turkey. Physics course is taken as compulsory by all secondary school students at the grade of 9. Therefore, 9^{th} grade physics curriculum was planned to be more general and to include more skills than the other grade physics curricula. The content of 9^{th} grade physics curriculum was determined by taking into account that all high school students take physics course at the grade level of 9. Since the 9^{th} grade physics curriculum aims to educate *all* students at the secondary school to solve daily life problems by using the fundamental physics concepts and problem solving skills, it is chosen to be taken under investigation for this study.

It is essential for any curriculum reform to follow the changes in the features of the curriculum like textbooks and implementation of the curriculum. Changes in physics curriculum are supposed to be reflected to both textbooks used in physics course at nationwide in Turkey and teaching activities of physics teachers. In this study, the focus is on intended and implemented curriculum by way of analyzing the curriculum, the textbook and the teacher activities. Adjacent to the curriculum itself, textbook is investigated under the umbrella of intended curriculum. According to Flanders (1994), textbooks which are given over-reliance by teachers are regarded as representing the intended curriculum. On behalf of the implemented curriculum, classroom activities and the textbook used in the physics lessons are analyzed.

Textbooks are extremely important for the education in Turkey; teachers are expected to use the textbooks which were approved by the Ministry of National Education. Textbooks are written with respect to the criteria developed by The Board of Education and are examined through these criteria. The textbooks which meet these criteria are decided to be used in schools (Ministry of National Education Regulations, 1993). Hence, textbooks used in schools in Turkey are decided by the Board of Education at nationwide.

Studies conducted in Turkey (Dökme, 2005, 2004; Koray, Bahadir, & Geçgin, 2006) about textbook analysis with respect to science process skills show the percentage of each science process skill in the science and chemistry textbooks. The studies of Dökme (2005, 2004) focus on the 6th and 7th grade science textbook published in Turkey and study of Koray, Bahadır, and Geçgin (2006) investigated the 9th grade chemistry textbook. Many studies exist about the analysis of textbook focusing on evaluation of 9th grade physics regarding to teachers' views (Arslan, Teknıyık, & Ercan, 2012); the educational, visual, language and expression point of view (Güzel & Adıbenli, 2011); developing criteria for textbook analysis (Demir, Maskan, Çevik, & Baran, 2009). However, there is a lack in the literature about the analysis of 9th grade physics textbooks with respect to science process skills in Turkey.

Analysis of physics lessons are important in order to understand the transmission of the skills implied in curriculum and included in the textbook written to corresponding curriculum into the physics lesson. Since the aim of the changes in the curriculum and so in the textbook are for the physics lessons to be more process-based. Therefore, 9th grade physics lessons are necessarily affected by the improvement of 9th grade physics curriculum, and the changes in the 9th grade physics textbooks.

In conclusion, the aim of this study is to reveal the extent of the presentation of science process skills in the 9th grade curriculum, the 9th grade physics textbook, and the 9th grade physics lessons. Moreover, the purpose of this study is to describe the gap among the 9th grade curriculum, the 9th grade physics textbook, and the 9th grade physics lessons in terms of inclusion of science process skills.

1.2 Research Problems

The purpose of this qualitative research study is to reveal to what extent the science process skills are included in the Turkish 9th grade physics curriculum, 9th grade physics textbook, and 9th grade physics lesson. Specifically, the study addresses the following research questions:

1. To what extent are science process skills included in the Turkish 9th grade physics curriculum?
2. To what extent are science process skills included in the content of the 9th grade physics textbook published by Ministry of National Education?
3. To what extent are science process skills included in the 9th grade physics lessons in the Energy chapter?
4. To what extent are 9th grade physics curriculum, textbook and lessons consistent to each other in terms of science process skills?

In order to answer the first and second research questions, Science Process Skills Code Book (SPSCB) was constructed by the researcher. The 9th grade physics curriculum and 9th grade physics textbook were coded by using the mentioned code book. For the third research question, classroom observations were conducted in three lessons during Energy chapter. The chapter of Energy was chosen because it is one of two chapters which have many skill and content objectives in number. The other one is Force and Motion however this chapter has already covered by many teachers included in the study at the time observation started. The physics teachers of these lessons were among teachers who have been chosen as the best implementers who focus developing the students' skills mentioned in the curriculum. Furthermore, the teachers were interviewed to answer the third research question. All data collected with respect to first three research questions were compared in order to answer the fourth research question.

1.3 Definition of Important Key Terms

1.3.1 Science process skills

Science process skills are defined as the understanding of methods and procedures of scientific investigation (Bilgin, 2006). In this study, eleven science process skills were focused specifically; observing, classifying, measuring, inferring, predicting, scientifically communicating, formulating hypotheses, controlling variables, interpreting data, experimenting, and modeling. The first six skills are categorized as the basic science process skills, while the last five skills are categorized as the integrated science process skills (Burrchfiel, & Gifford, 1995; Ostlund, 1998; Rohaida, 2004).

1.3.1.a Domains and dimensions in the code book

In this content analysis, codes are grouped under two main domains named as knowledge-based and skill-based. Knowledge-based codes refer to the any information about science process skills like historical facts, specific events, generalizations, explanations about science process skills. On the other hand, skill-based codes refer to any action to develop students' science process skills in physical, mental aspects and/or both. These domains have two dimensions; the codes of these dimensions for each science process skill are explained in the SPSCB (Appendix A). In this part, the definitions for them are given in brief.

Knowledge-based domain

Declarative-knowledge: Learner is informed about facts, generalizations and vocabulary terms defined by Marzano, and Kendall (2008). Facts convey information about specific person, places, things, and events. Generalizations are statements for which examples can be provided. Vocabulary term is a word or phrase about which a student has an accurate, but not necessarily deep, level of understanding (Marzano & Kendall, 2008).

Procedural-knowledge: Learner is informed about procedure of the skills and explained "how-to" perform the skills. It typically starts with declarative knowledge; the individual cannot perform the procedure but is aware of the requirements. With practice over time, the individual learns to execute the procedure (Marzano & Kendall, 2008).

Skill-based domain

Task-based skills: Learner is given a well-defined task to perform the skills.

Transferable skills: Learner is expected to transfer the skills from one phenomenon to another.

1.3.2 The 9th grade physics curriculum

The physics curriculum published by Board of Education has been used since September, 2007. In this research, the last edition, August, 2011 is taken under consideration (TTBK, 2011).

1.3.3 The 9th grade physics textbook

The 9th grade physics textbook published by the Ministry of National Education has been used nationwide since 2008. Third edition, published at 2010 is investigated in this study (MEB, 2010).

1.3.4 The 9th grade physics lessons

The activities including all behavior of teachers and students are observed at 9th grade physics lessons during the chapter “Energy” in the second academic semester of 2012-2013 academic year.

1.4 Significance of the Study

This research provides insight into issues related to science process skills to curriculum developers, textbook authors, and physics educators. The results obtained from the study may help curriculum developers to determine the gap between the curriculum, textbook and the lessons as the implementation of the curriculum about the inclusion of science process skills. This knowledge may provide implicit guidance to physics curriculum developers as they design the new physics curriculum focusing to develop science process skills. If physics educators understand the science process skills and recognize them in existing curriculum, they will be better equipped to make informed judgments concerning their implementation. There is a documented gap between intended and implemented curriculum. It is important to determine this gap for the studies of the curriculum leaders who aim bridging the gap between curriculum and textbook and physics lessons in terms of science process skills.

Textbooks are frequently used by teachers and students and convey a great deal of information based on the curriculum in physics lessons (Chieppetta, Fillman, & Sethna, 1991). There have been many researches in the literature about textbooks due to the importance as teaching aids in the classroom. However, only few studies focused on implementation of science process skills in textbooks (Chiappetta, & Fillman, 2007; Dokme, 2004; Karamustafaoğlu, & Ustun, 2004). This study aims to expose to what extent science process skills included in the textbook and how it is congruent with curriculum. Textbook writers may benefit from the results of this study as they read and interpret the curriculum while writing the textbooks.

In this study, physics lessons of teachers who claim they follow the curriculum and focus on skill objectives in the curriculum are observed. By observing these physics lessons, comprehensive information is gathered about how teachers include science process skills. These findings obtained from observations will be valuable to develop in-service teacher education to understand how these skills can be included in classroom setting.

For the purpose of determining to what extent the 9^{th} grade physics curriculum, the 9^{th} grade physics textbook, and the 9^{th} grade physics lessons include science process skills, content analysis was conducted. In order to construct a content analysis, the fundamental step is to prepare a codebook. The detailed explanation of the procedures for preparing the SPSCB for curriculum, textbook and observation of classroom are another contribution of the study to the literature on science process skills and content analysis. Moreover, the SPSCB can be used to analyze any written document with respect to science process skills in order to determine what extent these skills are included in the document.

CHAPTER 2

CONCEPTUAL CONTEXT

In this chapter, theoretical framework that informed this research and the literature discussing the prior studies that contributed to the research is covered. In the first section, theoretical construction of each science process skill is clarified. Next, the second part focuses on review of literature on how science process skills are analyzed in science curricula, textbooks or laboratory materials, and instruction. By doing so, the rationale of the study will be made clear within the ongoing literature.

2.1 Theoretical Framework of the Study

In this section, theoretical framework of the study and literature review on science process skills are covered in two main sections. In the first section, brief information on science process skills is presented to provide the context for the problems of the current study. Each skill under investigation is defined and explained with respect to the literature. These definitions and explanations construct the framework of the study. Then, importance of these skills is stated in the light of literature.

In the second section research on science process skills are presented accordingly three research questions of the study; studies about curriculum, textbooks and instructions are involved, respectively. In these parts of the second section, literature review is given without criticism. Researches associated with this study are criticized in the summary of literature review part which is the last one in this chapter.

2.1.1 Science process skills

The concept of science process skills has been always underlined as a critical feature of science education for over a hundred years (DeBoer, 1991). Layton, in his book named as Science for the People, 1973 (as cited in Marshall, 1990) stated that the characteristics of science was the method in which knowledge was acquired. That is the inductive aspects of scientific method which means more than conclusion of scientific activity. Layton reported that science was considered in the schools not only for its informational benefits but also because it trained the power of observation and reasoning. Similarly Gagne, (1963, 1965) Livermore, (1964) and Nordland & Devito, (1974) also emphasized teaching science as a process. The rational basis upon Gagne's view is that knowledge develops inductively from sensory experience. This view of induction as the method of science was proposed by

Francis Bacon in 1602, Robert Boyle in 1672, and Sir Isaac Newton in 1687. According the basic views of induction, science consists of four stages:

1. Observation and the collection of facts,
2. Analysis and classification of those facts,
3. Inductive derivation of generalizations from the facts, and
4. Further testing of the generalizations.

Gagne's view of science as inductive is consistent with the classical position of Bacon, Boyle, and Newton. Science begins with observation and proceeds through systematic organization of data, the inductive formation of inferences, and the testing of those inferences. According to Gagne (1970), concepts are formed from individual sensory impressions that are similar and adjacent in the experience of an individual. At the same time Gagne underlined the prerequisite knowledge of concepts and principles can be obtained only if the students have certain capabilities to practice and understand science. The key features of these processes across content are:

1. Each process is a specific intellectual skill used by all scientists and applicable to understanding phenomena.
2. Each process is an identifiable behavior of scientist that can be learned by students.
3. The processes are generalizable across content domains and contribute to rationale thinking in everyday affairs (Gagne, 1965).

Gagne in brief, defines science process skills as intellectual skills used for developing knowledge and understanding. The skills are a set of broadly transferable abilities, appropriate to all of the science disciplines, and reflective of the true behavior of scientist when conducting experiments and solving problems. Science process skills are described by Tobin and Capie (1982) as follows:

> Intellectual skills used in collecting and analyzing data to solve problems. Students can use process skills to formulate responses to questions, to justify viewpoints, to explain events and procedures, and to interpret or describe data. Processes such as observing, classifying, and recording data, which are typically taught in elementary grades, act as prerequisites for integrated processes such as hypothesizing, controlling variables, and defining operationally… (p.113)

Kujawinski (1997) emphasized that today's students are being prepared to understand the dynamic nature of science as they are part of the world as scientist. Students can understand the world by science process skills (Kaptan, 1999). In addition, Huppert, Lomask, and Lazarowitz (2002) emphasized the function of science process skills in global society that those skills are not only needed by scientists, but by every citizen in order to become a scientifically literate person.

Science processes skills are defined in different ways by many scientists; similarly they are considered in different categories. According to SAPA, primary process skills are observing, classifying, measuring, communicating, inferring, predicting, using time/space relationships, and using numbers (Padilla, & Okey, 1984). Martin's (1997) classification includes observing, classifying, communicating, measuring, predicting, and inferring in basic process skills. Temiz (2001) considered observing, measuring, using time/space relationships, predicting, and classifying in the category of basic science process skills. Lancour classifies the basic process skills similarly; the difference is that Lancour's classification does not include using time/space relationships, and using numbers. In this study, similar to Lancour classification, basic science process skills are consist of observing, measuring, classifying, inferring, predicting and communicating. Using time/space relationships and using number is not taken to the study, because based on the ages eleven at which Piaget (as cited in Casasanto, Fotakopoulou, Boroditskyc, 2010) reported that children set their confusion about space and time. Therefore, at secondary school students at the ages between fifteen and eighteen have already gained the skills of using time and space relationships.

Integrated process skills at SAPA are formulating hypotheses, naming and controlling variables, making operational definitions, experimenting, interpreting data and investigating (Padilla, & Okey, 1984). Martin's (2007) classification involves determining and controlling variables, formulating hypotheses, interpreting data, making operational definitions, experimenting and modeling as integrated process skills. Saat's (2004) classification similar to Martin's, involves controlling variables, making operational definitions, formulating hypotheses, and experimenting in the category of integrated process skills. Temiz (2001) included formulating and testing hypotheses, determining and controlling variables, making operational definitions, modeling, designing and generating experiment, comprehending cause-effect relationship as experimental skills in his master thesis. In this study, formulating hypotheses, identifying and controlling variables, making and designing experiment, collecting and interpreting data, and modeling are considered in the category of integrated science process skills. In the following sub-sections, the definitions of each science process skills in the framework of this study are given.

2.1.1.a Observing

Observing, the essence of all science, is the basis of collecting data by using all appropriate senses and instruments that extend the senses to gather information and/or describe a process, object or event (Buxton, & Provenzo, 2007; Carin & Bass, 2001; Harlen & Qualter 2009). While making observations; specifications of objects, changes in their movements and structures, changes in the events are taken into consideration (Buxton & Provenzo, 2007). In observing, all appropriate senses are used which are the five basic senses of sight, sound, taste, smell, and touch. The sense of balance, the sense of muscle contraction, the sense of muscle memory, the sense of direction, and the muscular senses can also be used, for example when we investigate how heavy something is. Observing is fundamental for all other skills since the concrete information gained through observation forms a basis for higher levels of thinking.

Observation may be qualitative, quantitative, or both in the same activity. Qualitative observations are the ones that are made directly with sensing organs; such as observing the growth in length of a flower, roughness of the surface, smell of spoiling fruit. Quantitative observations are based on data with standard or non-standard units related to things or events (Martin, 2006). For example, indicating the growth in the length of a flower with numerical figures is a quantitative observation. Moreover in both type of observation where attention to detail or to slight changes is required it will be proper to extend senses by using an instrument such as a hand lens or stethoscope and to use measuring instruments to quantify observations (Harlen & Qualter, 2009)

Systematic and controlled observation is fundamental to scientific inquiry. What makes systematic and controlled observation different from the observations made in daily life is that it starts with a guiding question (Buxton, & Provenzo, 2007). Systematic observation is based on direct experience with the object, event or process without regard to inferences. However, interpretations of observations are based on prior personal relevant knowledge and ideas brought into the situation (Carin, & Bass, 2001). Planning the observation makes it easy to control the process, not to skip any important things or repeat observations unnecessarily, and to observe not only expected things but also unexpected and important things as well. It is important to be curious and have an open mind while observing; be aware of discrepancies; ask questions that can lead to new observations and new information.

Teaching students to be discriminating observers is one of the major objectives of science education. In the science lessons it is important to keep in mind that science begins with observation, in this sense making careful observations is needed in the study of science. The role of observing should be emphasized for other skills like inferring and predicting. Moreover, experimenting involve the collection of data which is attained by making observations (Gabel, 1993).

While planning the lesson including observation, it is important to maintain class discussion on the observation level until a number of responses have gathered. With the intention of waiting for more responses, students are given chance to join the discussion and time to build explanations for what they observe. Students' observational information can be written to compare and discuss on it in order to emphasize the difference between systematic observation and the observation in daily life (Carin & Bass, 2001).

Moreover teacher can put exploration, observation, and description to the focus of the lesson by asking open ended questions. For example, teacher can ask questions of "what are some of the things you noticed during the demonstrations". This may let many students to contribute valuable responses during observation process (Carin & Bass, 2001; Gabel, 1993).

2.1.1.b Measuring

Measurement is counting and comparing with its simplest meaning. It involves the use of a variety of tools to quantify the dimensions of an object or event (Buxton & Provenzo, 2007). Measuring is describing measurable things by means of standard or non-standard units. Measurement process can be made either with standardized devices or non-standardized methods. Informal measurement is called when measuring takes place like comparing shoes end to end, using length of arm, hand, or any other uniform objects which is not standardized in unit. For example, students can use/count how many shoes long a wall of a classroom and count the number of steps taken, and represent the length of the wall in terms of a length of shoes of a student. Formal measurement is defined as using a particular standards as well as specific devices for measuring. For instance, when students measure the length of the wall with a ruler in meters, it means they used standardized device and made formal measurement (Wolfinger, 2000).

In science classes students should practice in using both standardized and not-standardized measuring instruments. According to Carin and Bass (2001) and Buxton and Provenzo, (2007) students should begin to understand

- How to use a variety of measuring instruments;
- The meaning and use of various standard units of measurement;
- How to interpolate between numbers in reading thermometers, rulers, and other instruments;
- How to express measurements in terms of decimals when appropriate;
- How to estimate measurements and when the estimation is appropriate.

Additionally, the skill of measuring includes estimating, or approximating a measurement without using a measurement tool. Measurement is an important science process skill because the quality and precision of predictions and explanations can be improved by making measurements (Carin & Bass, 2001; Buxton & Provenzo, 2007).

2.1.1.c Inferring

Inference is described as the best guess of a person about why something happened by Settlage & Southerland (2007) and Martin (2006). It involves drawing a conclusion about something happened, based on past experience and previously gathered information. For an experiment setting, inference is the interpretation of the observations made during an activity or experiment (Buxton & Provenzo, 2007). According to Carin and Bass (2001) inferring is to interpret the observations that is based on pre-existing knowledge and experiences. Inferences are made up of three interacting components: (1) observations; (2) prior knowledge and experiences; and (3) interpretation. In addition, an inference may also be defined as a statement showing a relationship among the parts of a system detailing a cause-and-effect relationship (Wolfinger, 2000).

Prior experiences and knowledge are very important while constructing an inference. For example, if an inference is made about natural phenomena the prior knowledge must consist of related and dynamic, rather than isolated and static ideas. The pre-existing information like “Air often contains water vapor”, “Water vapor comes from evaporated water “, “When warm, moist air is cooled to a temperature called the dew point, water vapor from the air will condense onto available cool surfaces” are necessary to support the inference “the moisture on the glass of ice water comes from the surrounding air” (Carin & Bass, 2001).

It is important to distinguish inferring from observing and predicting. Carin and Bass (2001) highlighted that observations are statements about information directly gathered through five senses; inferences are interpretations of these observations. Past experiences and prior knowledge are used to fill in gaps about observed events and information. Next, inferring is different from predicting; predicting is statement about what will happen whereas inference is a statement about cause of something that happened before (Martin, 2006).

Inferences are opinions informed by facts, but they are not facts themselves. An inference is better when it makes sense in explaining the several numbers of observations. In other words; the more reliable inference is possible with more valid observations. Scientific inferences are evaluated by scientist, and tested whether they are still satisfactory by gathering evidence. If it is not sufficient any more, a scientist can propose a new inference, and so as the old inference can be discarded because the new one does a better job of explaining the data (Settlage & Southerland, 2007).

As students are asked to make inferences, they will construct more ideas to be tested. They can be tested in different ways; reading, careful observations, and generating activities. Making inferences and testing these inferences allows students to work like scientists. Making inferences and testing starts a circle between other science process skills; making predictions, observing, collecting data, measuring, etc. (Wolfinger, 2000).

2.1.1.d Classifying

Classifying is the process of placing objects into groups based on observable properties, characteristics either *do* or *do not* possess. The ability of classifying starts from placing objects according to a single criteria which is simply, and easily observable and goes to more complex hierarchical classifications. For example classifying regarding to color, smell, or shape of object is simple classification whereas biological classification system is a complex one (Buxton & Provenzo, 2007; Settlage & Southerland, 2007; Wolfinger, 2000).

Classification, an important way of organizing the information, depends on knowledge and/or the data which were obtained by observations (Wolfinger, 2000). Classification should be conducted according to properties of objects or events that can be observed. Observing is an important skill for classifying, on contrary inferring has no place in classifying. Five senses provide powerful observational tools to understand the world around us and then to classify what is observed (Buxton, & Provenzo, 2007).The best parameters to be used for classifying are those that are unambiguous, clear, and based on observations, not inferences. In brief, classification parameter should be objective. For example, classifications of cinema films in terms of their type is much better method than classifying them by boring or funny (Settlage & Southerland, 2007). Parameter should be clear; it should clearly separate the object into one of two different categories.

Preoperational child can deal with only one attribute at a time where an early concrete operational child recognizes that the same objects may have more than one attribute. The ability of devising parallel classification occurs during the mid-concrete operational stage. At this level students are able to abstract the specific cases of general common attributes possessed by each item that make some difference in classifying. Students need workout developing parallel classification systems for a better classifying skill. It is critical to ask students why they grouped in the way they did so as to learn their rationale about the process of classification. Students in the late concrete operational or early formal operational stage of cognitive development, can group hierarchical systems of classification that require higher levels of cognitive skills (Martin, 2006).

It is essential to understand that the ability to classify does not appear instinctively within students; they must be exposed to the phenomenon. In the classroom, students must be encouraged to do many activities sorting of using many different kinds of things to gain experience in the skill of classification (Martin, 2006). However, classification itself can be used as a direct teaching method to develop a particular concept or can be used as a way of introducing a new topic of study (Martin, 2006).

Moreover a classification made by scientists can also be the topic of a lesson. While present classification systems are important to scientific literacy, it is also important for students to learn how to construct classification systems by comprehending the scientific examples (Buxton & Provenzo, 2007). In this case, it is important to emphasize how scientists classified the objects or events. The information about the classification parameter should be explained with the properties of it. Moreover, Settlage and Southerland (2007) states students should be shown that any current classification system is only the most recent in a continued process of pattern seeking and sense making. In other words, knowing about existing classifications is as important as knowing how to classify and being given the opportunities to develop classification skills (Wolfinger, 2000).

Therefore, the materials in this study was analyzed according to giving information about classification itself; that is how to classify objects and events, comparing common and different characteristics of objects and events, mentioning about the properties of objects or events and making students to develop classifying skill by sorting objects or events.

2.1.1.e Predicting

Predicting is foreseeing the possible outcomes of an unrealized event depending on the past experiences and collected data. In other words, a prediction is an individual's best guess based observation, or other evidence as to what will happen next in a given situation. (Buxton & Provenzo, 2007; Carin & Bass, 2001; Martin, 2006; Wolfinger, 2000). A prediction is not simply a guess. A guess has no basis in data, whereas a prediction must have a rigorous base in data that was previously collected or experienced (Wolfinger, 2000). For example, when rolling toy cars down a ramp carpeted by different textures in an experimental setting, students might use their past experiences riding a bike or rollerblading to predict that the toy car will travel faster on a smooth piece of plastic than on a piece of artificial grass (Buxton & Provenzo, 2007). Predicting has three interacting components: (1) Prior scientific knowledge, (2) A forecast, and (3) A possible outcome.

Predicting is related to other process skills; observations and meaningful inferences play an important role in making reliable predictions. Ordered observations often result in the recognition of patterns which may be used to predict what will be observed in the future. Testing a prediction makes the investigator observe new phenomena and make inferences about the outcome of observation (Rezba, et.al, 2007). The inter-relationship among these science process skills can be presented as in Figure 2.1;

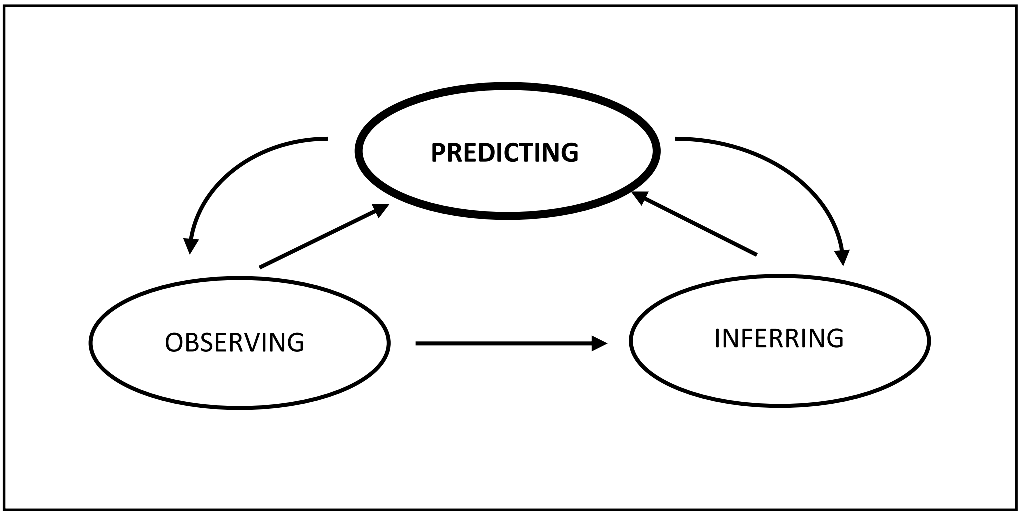


Figure 2.1 Inter-relationship of predicting with observing and inferring

As the figure shows that observing, predicting and inferring are interconnected process skills. Testing the predictions leads to making more observations; they either support or not support the proposed predictions. As new observations are in agreement with the prediction, it will become stronger and convincing. On the other hand, when new observations do not support the prediction, it will be rejected and need to be re-examined. Then, new observations cause new inferences and new predictions. Hence, the relationship between these three skills looks like Figure 2.1. As new observations are held as a process of gathering data, inferences and predictions are proposed to explain what has been observed and what has not been yet (Rezba, et al., 2007).

Despite of having some logical similarities with inferring; predicting has some critical differences. Predictions look forward, state what might happen next, while inferences look backward, explain the reason of what has already happened (Carin & Bass, 2001).

Prediction is crucial for doing science and students should be encouraged to predict before they test. By doing so, students learn to compare what in fact happens with what they thought would happen, rather than merely accepting what happened without thinking about it. The discrepancies between predicted and actual occurrences lead students to further investigations. Moreover, students realize that their predictions may be correct, wrong or deficient; so they should test their predictions to determine the validity. Students' predictions may be tested through reading or use of concrete materials. Events may result in the way they predicted or not, but the point is to learn if the prediction is correct, wrong or deficient by testing it. Once the predictions have been tested, students can modify predictions according to the new data and finally when all of the evidence is in, they can draw conclusion. Thus they will take part in scientific research which is a process of continuously predicting and proving or disposing of an argument (Martin, 2006; Wolfinger, 2000).

In science classes, the most important question can be asked to students “What would happen if …” in order to develop the skill of predicting. This question arises from the observations and curiosity about the result of the observation (Buxton & Provenza, 2007). Thinking about predictions in terms of three components mentioned above, teachers might ask “Why do you think so?” to make students state the prior knowledge base supporting the prediction (Carin, & Bass, 2001).

2.1.1.f Communicating scientifically

Communication is transmission of information to other people in any formats. It includes nonverbal behavior as well as verbal behavior. Writing, drawing, talking, gesturing, telling stories, giving oral presentations, pantomiming, singing are different ways of communicating (Martin, 2006; Wolfinger, 2000). Likewise, communication can take many forms: graphs, charts, concept maps, graphic organizers, diagrams, posters, symbols, maps, and mathematical equations (Buxton, & Provenzo, 2007; Martin, 2006; Wolfinger, 2000).

Communicating scientifically, on the other hand means sharing and making discussions about the whole or a part of a scientific research. Sharing, judging and analyzing of scientific researchers are very important not only for improvement of the science, but also for repeatability of the investigations, and experiments. Scientific discovery relies on a continual process of communication within the scientific community so that its members can build upon the work of others. For example; Faraday built his ideas on electromagnetic properties by the help of the electrical experiments conducted by Franklin, Volta, and Lavosier which was published in detail in the nineteenth century (Buxton, & Provenzo, 2007). Thus, it plays a critical role in many significant discoveries.

Sharing the process of an experiment and the result of the experiment is a very important science process skill (Buxton, & Provenzo, 2007; Martin, 2006; Wolfinger, 2000). Communication about scientific findings generally improves precision, clarity, and consciousness of new scientific investigations. Communication can be generated at and about any step of scientific method for any type of research (Martin, 2006).

In order to develop students’ scientific communication skill in the classroom, students can be given chance to discuss, describe, and explain the work they done. In the classroom, students communicate in small or large groups, in individual conversations with each other, in discussion sessions, and so on. For example, the results of observation can be shared with other students in the classroom, the way of collecting data may be discussed in group discussion session, and the whole process of an experiment may be explained by a group of students to the rest, and so on. The important point is to give students the maximum opportunity to develop accurate communication skills. For example, they can present their activities and the results of their investigations orally in the form of class demonstrations (Martin, 2006).

2.1.1.g Formulating hypotheses

A hypothesis is a testable statement of the investigator's best guess depending on experience and observation as to the relationship between two variables (Martin, 2006). Hypothesis can be made either for a problem or for some events and properties, even for discovering the relationship between variables. Hypothesis is a kind of prediction that proposing how the effect of independent variable on dependent variable will be (Bailer, Raming, Ramsey, 1995). However hypothesis formulation is different from prediction. In prediction, it is answered that what would happen if we did something; it is related to only the result of not occurred event yet. In hypothesis formulation, it is stating what would happen to one variable if we change an interacting variable.

Hypothesis is also called an educated guess (Wolfinger, 2000). However, when the hypothesis is defined as educated guess it is more likely to be confused with prediction. For example an educated guess can be simple as "It will rain tomorrow". It is only a prediction not a hypothesis to test through control of variables. On the other hand, when the hypothesis is called an "if… then" statement, it will provide the student with a format for writing a hypothesis. Moreover, this statement will cover the way for identifying the dependent and independent variables in an experiment for students (Wolfinger, 2000). For example, if the height of object falls through is increased, then it will fall faster. The experimenter can tell that the height of the object is to be purposely changed; it is the independent variable. From this change in the height of the object, the experimenter expects a change in the velocity of it. The velocity of the object depends on the height that it falls through and the velocity is the dependent variable. Thus, the hypothesis let the researcher design the experiment.

In this study, evaluating a hypothesis being testable is important as constructing a testable hypothesis. Hypothesis pointing the center point of a research, guides researchers about the independent and independent variables. The steps for writing a good hypothesis are given by Raming and Ramsey (2006) as:

1. Identify variables in a given event or relationship
2. Identify a pair of variables that might be logically related.
3. Identify the manipulated and responding variables
4. Write the hypothesis using the following format: If the (manipulated variable) increases or decreases, then the (responding variable) will increase or decrease (p.101).

For the skill of hypothesizing it is important to inform students that being testable is more important than being correct for a hypothesis. Researchers do not know what is going to happen and so the hypothesis may not be validated by the experiment. This should not be interpreted as failure for the students in an experiment, actually, it should be taken as a result to learn what happens and how to correct the prediction and make a new hypothesis (Wolfinger, 2000).

2.1.1.h Identifying and controlling variables

A variable is a quantity or a characteristic that takes different numbers or changes over time. There are two basic type of variable namely; independent and dependent variable. Independent variable is the one which cause changes in other variables resultant to its changes, and dependent variable is the one which changes in response to change in independent variable.

Carin and Bass (2001) defined the variable as a property of objects or events that can change and have differing amounts. For example the amount of rainfall in a day, the height and weight of a growing child, the time a candle can burn under a glass jar. Beside the terms independent and dependent variable Carin and Bass chose to use the terms “Manipulated”, “Responding”, and “Controlling Variables”. A manipulated variable is a variable that the experimenter purposely changes; independent variable. A responding variable is a variable that changes in an experiment in response to changes in the manipulated variable; dependent variable. Control variables are variables that are purposely stayed constant in an experiment in order not to confound the results.

Similarly, a variable is defined by Buxton & Provenzo (2007) as any factor that could change, intentionally or unintentionally, during the course of scientific inquiry. In an experiment only one variable is changed at a time in order to understand which variable effect the dependent one. While changing only one variable, the rest should be stayed constant which is called as controlling the variables. An investigator conducting an experiment needs to identify all possible variables which may have an effect of dependent variable. Next, each time only one variable should be changed while the others are being controlled in order to find the affecting variable on the test result. Thus, influence of the independent variable on dependent variable can be explained in an experiment. Moreover, the investigator should identify the variables that cannot be controlled in order to interpret the result of the experiment (Peters, & Stout, 2006).

Controlling the variables is a process that only becomes possible when an individual has reached the level of formal operational thought, the final stage of development hypothesized by Piaget (as cited in Wolfinger, 2000). When children reach the age thirteen and fourteen, they can gain the skill of controlling variables.

In brief, in this study as identification of variables is defined as enouncing all effecting factors, and independent variables for an experiment. Controlling variables is; not only determination of the variables which will be changed and/or controlled, but it is also changing only independent variable, which will be tested, by stabilizing all other variables excluding independent one (Arthur, 1993).

2.1.1.i Making and designing experiments

Scientists attempt to realize and clarify the natural world through the experimental method. But, they do not simply work unprepared in the laboratory or in the field. Scientists have a purpose for their work. They break down events into variables in order to handle one variable effect on another one in order to eliminate the complex effects of many factors or variables. If enough variables are taken in the study in the investigation, clear understanding may be the result. Ramign and Ramsey, (2006) stated that scientists ask a question about how one variable will affect another variable in an experiment. Similarly, Martin (2006) defined experimenting as the scientific process in which the investigator explores the effect a change in one variable has on the change in a different interacting variable. For example, investigator may wish to examine the effect of changing the length of a resistor on the electric current of a circuit.

As Settlage & Southerland (2007) mentioned that to design an experiment needs to bring together all of the process skills, both basic and integrated, for the purpose of testing an investigable question. Making an experiment is a complex skill that involves all other skills. Basic purpose of making experiment is to test the hypothesis or predictions, in such a way that making an effective plan to detect the effect of a selected independent variable on the dependent variable.

Experimenting is different from formulating hypotheses. While a hypothesis is constructed, no systematic attempt is made to examine verification of the hypothesis. Defining effect of a variable on a different interacting variable is even not enough for experimenting. It is called as experimenting when the investigator makes careful plans to explore the effect of changing one variable on the change in the other interacting variable (Martin, 2006).

Experimenting starts with determining the purpose, so students should make purposeful experiments or activities as a part of their work in science classes. Experimenting skill involves the skills of; choosing suitable tools and devices for prediction or hypothesis, using those tools and devices properly, building up suitable setup according to the purpose of the experiment, obtaining data by controlling variables, evaluating the prediction or hypothesis by reaching to a rational conclusion (Settlage & Southerland, 2007). As experimenting involves all other skills it may be difficult to differentiate this skill from others. Therefore both of below aspects should be checked:

- Predicting the result of the experiment or making hypothesis for explaining the relationship between two variables before starting to the experiment.
- Testing the prediction or hypothesis.

In this study, the skill of experimenting is handled in two way; (1) making an experiment which means teacher-structured experiments, cook-book experiments, structured experiments and (2) designing experiments which means student-structured experiments.

Making an experiment

In this structured experiments, the hypothesis, steps of the procedure are given to students by textbook and/or teacher. Students are expected to follow the steps of procedure. This type of experimenting allows students to see how an experiment is constructed; beginning with hypothesis, how to control variables, how to collect and organize data, draw conclusion about the hypothesis with respect to result of data, etc. Because of their difficulty in using experimental processes, students' first experience can be a structured experiment, with the teacher/textbook giving the hypothesis, the procedure, and the means for collecting the data. The point is to discuss with students about the way of conducting experiment and to start with a question asking the purpose of the experiment. In the structured experiments, it is important to highlight the procedure; how to control variables, how to collect and organize data and etc. by means of developing students' experimenting skills.

Designing an experiment

When students are given background information and a problem to solve, they are free to develop their own hypothesis to solve the problem and choose the experiment settings. In this stage, they are not given the hypotheses and the procedure to follow any more. The use of science process skills has been shown to be strongly correlated with the development of formal operational thought processes of Piaget (Padilla, Okey, and Dellashaw, 1983). At this final stage it is also possible to have students generate experiments from operational questions. Because of the need for formal levels of thought, many children may be unable to carry out a true experiment without extensive teacher direction. For these students, they may be given the opportunity to investigate scientific phenomena through the use of operational questions and no controlled activities (Wolfinger, 2000).

2.1.1.j Collecting and interpreting data

Collecting data skill is gathering qualitative and/or quantitative data depending on prediction and hypothesis. Transforming the data into different forms such as table, graph, and chart is also included in this science process skill. Interpretation is the ability to determine the relationship between dependent and independent variables by inferring the data in a logical way (Raming, & Ramsey, 2006; Martin, 2006; Wolfinger, 2000). Three important aspects of collecting and interpreting data are;

(a) Data should be collected according to the purpose,

(b) Data should be organized in most suitable format for reaching in a valid conclusion,

(c) Thinking on the data to conclude with logical result.

The first step in interpreting data is to decide on what data to gather and what kind of information is needed in the light of hypothesis (Martin, 2006). Then, before conducting a meaningful investigation, it is important to learn how to organize the collected data.

Collecting data may include observation, measuring; however the point in collecting and interpreting data is to interpret what has been observed and/or measured to draw conclusion for the aim of collecting data. It is impossible to interpret data in any shape; collecting and interpreting data in this manner include organizing data in a most suitable shape for drawing strong conclusions. Quantitative data may be organized by using data tables and charts, graphs; bar graphs and line graphs; that allows researcher to get a visual image of the observations and measurements. It is extremely important to keep in mind that valid conclusions depend on good organization and clear interpretation of data (Ramign & Ramsey, 2006; Wolfinger, 2000).

2.1.1.k Modeling

A model is understandable, concrete and visual format of a concept, event, fact or systems, which are not normally, can be detected by five sense organs. Any object, drawing, mathematical equivalence, computer program or similar things can be models. Value of the model is its specification that explains how something works (Wolfinger, 2000; Martin, 2006).

A model is a simplified imitation that can help understand the real object or phenomenon better. Model engines, model skeletons, model solar systems, or model airplanes are examples for *physical model.* The benefit of making a physical model is to make smaller the object or phenomenon in order to control the experiments. Moreover it is also possible to make the object or phenomenon larger that its real size like as models of atom. Beside physical models, *conceptual models* are analogies or metaphors based on some characteristic or relationship to the real thing. Visualizing the human brain as a computer can help develop understanding about how a computer works. The important point for a conceptual model is to reflect the complexity of the phenomena; it should not be very simple for complex issues. Otherwise, it may not give a clear thought and may be impractical to use. *Mathematical model* shows a mathematical relationship that allows behavioral prediction without a physical model. For instance, mathematical modeling allows us to send satellites to orbit the moons of Jupiter without recourse to physical models of rockets, planets, moon, or satellites (Wolfinger, 2000).

To foster the skill of modeling, students should be encouraged to make their own representations to explain phenomena they observe (Martin, 2006). The use of models can be increased as students reach the six, seventh, and eighth grades levels. At these grade levels students begin to make the transition into formal operational thought processes. Physical models can be easily understood by students who reach these more abstract thought processes. In addition, students can create their own models for abstract objects or phenomenon (Wolfinger, 2000). Inhelder and Piaget (as cited in Wolfinger, 200) states by the formal operational stage, students are able to use mental models of reality; they are able to "go beyond known explanations to search for explanatory models, to extend models, and to compare alternative models of reality in order to account for the data obtained during an experiment or an activity" (p116). When using physical models, the late formal operational students can evaluate the model how it resembles to actual one.

2.1.2 Importance of science process skills

Remembering the enormous accumulation of facts has become gradually difficult and impractical by the rapid development in knowledge over the past few decades (Kuhn, 1993). According to this need of the new age, science education should focus on developing the skill related to obtaining data and information; evaluating it, communicating and etc. There may be several other benefits of the integration of processes into science curricula. According to Scharmann (1989), science courses including process skills influence the development of science content achievement as well as development of a better understanding of the nature of science. Harlen (1999) argued that science process skills should be put on and practiced in the context of science since they are one of the major goals of science education. The aim is to educate students to become scientifically literate in order to function in a society by using and applying them in their daily life. Therefore, science learning has to engage students in activities which require higher cognitive stage; namely the science process skills.

There are many studies from different areas like chemistry, biology, computer science, and physics which have shown that the development of students' process skills increased their problem-solving skills (Akkus, Kadayifci, Atasoy, & Geban, 2003; Alparslan, Tekkaya, & Geban, 2003; Chang & Weng, 2002; Huppert, Lomask, & Lazarowitz, 2002). The similar results of these studies show that science process skills are not context based and should be used in education because of being beneficial in the classroom. These studies emphasize that science process skills used in each showed increase in student achievement in problem solving.

Developing science process skills increases students' stability of learning science concepts. Science process skills are also generalizable skills to other disciplines. Developing science process skills (SPS) in science education will affect students' usage of these skills in different learning areas. According to the study of Thiel and George in 1976 and Tomera in 1974 (as cited in Aldous, 2005) basic science process skills can be taught and that when learned, can be transferred to new situations. Moreover, development of these skills has positive effect on students to control relationships and deal with problems in daily life (Temiz & Tan, 2000). Similarly, Bağcı-Kılıç (2003) states that science process skills are used in daily life experiences such as observing changes in objects or events, gathering data in order to make decision about daily life problems. Solving problems and changing relationships and/or attitudes are dynamic similar to procedure of developing science process skills.

Science process skills have an essential part in science curriculum. They represent the rational and critical thinking skills used in science. Competence in the process skills enables students to act on information to produce solutions to problems (Burns, et al., 1985). Similarly, Arena (1996) claims that science process skills should be a progressively larger part in science education because they help the students stay engaged in learning by citing the study of Roth and Roychoudhury (1993) in which students successfully used science process skills in solving an open-inquiry problem. According to the results of the study, the process skills are learned and made sense to the students in the context of inquiry.

Colvill and Pattie (2003) explain the importance of science process skills in a science curriculum as that they are inextricably linked to acquisition of new science knowledge. The study of Flehinger in 1971 supports this statement by pointing out a significant positive correlation between the level of process skills and level of knowledge acquisition for the experimental subjects. Students with high process skills level acquired significantly better in subject matter than students with low process skill level. In addition, Galgam and Grange (2003) found that most of the science content in process-based science curriculum was learned and remembered well by the learners.

Ostlund (1998) states that research points out process-based curriculum at sixties and seventies like Science-A Process Approach (SAPA), Science Curriculum Improvement Study (SCIS), and Elementary Science Study (ESS) were more effective in increasing performance and attitudes of students rather than the traditional programs were. Shymansky et al. (as cited in Ostlund, 1998) conducted a meta-analyses at 1993 on students' performance across these activity-based programs and the results show that these elementary science programs were more effective in improving student achievement and problem-solving skills than were traditional programs. According to results, students involved in at least one of these three curricula accomplished significantly better on the three of five performance areas.

The literature has included several studies addressing the effectiveness of teaching science process skills, reading skills, and problem solving skills to middle school students. Padilla, Okey, and Garrard (1984), stated that integration of science process skills in science curriculum systematically, increases students' skills mostly, in the areas of hypothesizing and identifying variables. Ostlund (1998) indicates the studies showing the positive relationship between science process skills and reading skills, and problem solving skills in mathematics. As stated with the result of studies of Barufaldi & Swift, 1977; Carter & Simpson, 1978; Lucas & Burlando, 1975; Mechling & Oliver, 1983; Murray & Pikulski, 1978; Simon & Zimmerman, 1980 and Wellman, 1978 (as cited in Ostlund), process-based science program emphasizing hands-on manipulative experiences provides the development of reading skills. For example when students used the process skills of observing, identifying, and classifying, they are better to classify the letters and syllables and to recognize the contextual and structural clues when attacking new words. Moreover, Wellman (as cited in Ostlund, 1998) concludes that process-based science program provides an alternative teaching strategy that motivated students who have reading difficulties.

The study of Linn, Clement, Pulos, and Sullivan (1989) showed that students' problem solving ability can be developed even when the instruction with these skills has given from seven to ten lessons. The studies of Mechling & Oliver in 1983; Coffia in 1971 and Shann in 1977 (as cited in Ostlund, 1998) show that students can apply mathematics to real-world problems through science experiences when the contrived problems were replaced with real-world science problems. Thus, it has the potential to improve the problem-solving abilities of students, while promoting a greater appreciation of the usefulness of problem solving in a multitude of situations. Furthermore, Bitner (as cited in Ewers, 2001) and Lee (1993) found significant positive relationships between students' logical reasoning ability and science process skills.

2.2 Research about Science Process Skills

There is vast amount of research studies in the literature about science process skills, investigating the effect of a special teaching strategy on these skills (Burchfield and Gifford; as cited in Myers, 2004; Mitchell, 1995; O'Sullivan, 1985), assessing and/or constructing a new instrument for assessing these skills (Aldous, 2005; Edward, 1990; Kujawinski, 1997; Mohamed, 2006), developing material for the improvement of science process skills in learners (Esprivalo-Harrel and Bailer, 2004; Greene & Greene, 2001; Gren, 1994; Solano-Flore 2000), etc. Burchfield and Gifford (as cited in Myers, 2004) found no significant difference in science process skill gains of students in the traditional class and those in the computer-assisted instruction class. O'Sullivan, (1985) investigated the effects of cooperative biological research experiences on high school teachers, students, and university scientists. The researcher found no significant difference for teachers' or students' understanding of science process skills. Mitchell, (1995) examined the effects of using a guided research format, in a block of laboratory sessions, on the achievement and integrated process skills ability of college students who varied in their level of cognitive development. He found that guided research treatment was beneficial in advancing the integrated science process skills, molecular biology achievement even the students who have lower cognitive development. Moreover, the studies Atwood and Howard (1990); Wilson and Chalmers-Neubauer (1990); Renner, staffordi Coffia, Kellog & Weber (1973) show that the process-based curriculum like SCIS, ESS, and S-APA provided students' performance noticeably superior to traditional programs The results of the study of Önder (2006) investigating the effect of conceptual change approach on students' understanding of solubility equilibrium concept indicated that there was a significant contribution of science process skills on students' understanding of solubility equilibrium concept. Başdaş (2007) investigated the effect of hands-on science learning in "Matter and Heat" unit on sixth grade students' science process skills, achievement, and motivation in his master's thesis. He found that experimental group students got significantly higher scores in all measures than those in the control group.

There are many studies focusing on the assessment of science process skills. Kujawinski (1997) investigated how science process skills of students may be accurately and reliably measured and evaluated. The researcher developed assessment instruments for evaluating student self-evaluation and performance of the science process skills. Mohamed (2006) developed the Scientific Creativity Test for fifth-grade students to identify scientific creativity with three subtests; problem and solutions, grouping flowers and design an experiment. Aldous, (2005) assessed genetics students' competencies in some of the science process skills required by practicing geneticist. Edward (1990) used the Test of Basic

Process Skills in Science (BAPS) for elementary and middle school students in order to gather evidence of the construct validity of the test.

Some activities are designed to develop only one or two science process skills while others develop a range of skills. Gren developed a test instrument in 1994 to diagnose and remediate this skill of observation. Similarly, Greene and Greene (2001) explained the use of amphibians and reptiles in the classroom to develop the skills of observation. In another study by Moore (2003), the skill of sorting and classifying was the focus of designed activities. Moreover, Esprivalo-Harrel and Bailer (2004) constructed a novel set of science activities for improving general biological skills using mealworms. These activities made students build understandings of how valuable science process skills are to understanding and making valid conclusions about science investigations. Solano-Flore (2000) designed an open ended activity called as “bubbles task” related to the concepts of force and motion in physics. The activity provides opportunities for students to find solutions which make the longest- and the shortest- lived bubbles by designing and conducting experiments.

The literature about science process skills is plentiful including studies on different grade levels, different research approach for varied research questions. The importance of teaching science process actively is also mentioned in much research. However, the reported literature in this review is bearing on the research questions for this thesis. The boundary of the literature review are the analysis of curriculum, analysis of textbook, analysis of instructional materials, and analysis of lessons, teaching/learning activities. The driving force behind the implementation of teaching science process skills is the curricula. Much literature brings out the degree of success of various curricula in the teaching of science process skills. Textbooks prepared accordingly process-based curricula are analyzed in terms of corresponding skills. Besides research on science process skills exploring methods for teaching science, teacher activities, and instructional materials are included in this review.

2.2.1 The research on analysis of curriculum on science process skills

The study of Jimarez (2005) emphasized the use of constructivist strategies promoted conceptual understanding while facilitating development of science process skills. The study focused on the following science process skills; (a) problem solving, (b) posing hypotheses, (c) selecting and testing variables, (d) experimental design, (e) recording data, (f) graphing results, and (g) explaining findings. A mixed research design embedded in a case study approach was used. Both quantitative and qualitative methods of data collection were used for robust interpretation of findings. 29 students at 9^{th} grade physical science classes were participated in the study. The study suggested that the use of constructivist strategies promotes conceptual understanding of science concepts and development of science process skills. For example, the windmill laboratory activity provided scaffolding for students to make connections between theories (concepts) and practice (science process skills). The data from field notes and videotapes during observed classroom interactions showed the development of students’ science process skills as students engaged in the windmill activity. For example student recognition of the meaning of changing only one variable at a time confirmed development of science process skills. Students constructed their own hypothesis and collected data to test their hypothesis in collaboration with their peers. Another evidence for the development of science process skills of students was that students were able to explain their models whether the model worked or not. Another finding of the study is that student responses for three integrated science process skills; use of variables and hypotheses, experimental design and graph interpretation showed a high increase in gains with the windmill activity. Moreover, researcher summarized that because of the sequential nature of the effects of the constructs, it was shown that meaningful learning of concepts and science process skills are dependent on each other and cannot be isolated. Science process skills are needed to conduct an activity; to achieve these skills; students must understand the applicable science concepts.

Turpin (2000) investigated the effect of an integrated, activity-based science curriculum on science content achievement, science process skills, and attitudes toward science. The research was conducted in seven integrated science classrooms using integrated science for the first time and seven traditional science classrooms. A quasi-experimental, non-equivalent control group design was used for the study. Analysis of covariance (ANCOVA) was used in order to establish group equivalence. Science process skills were one of the dependent variable in the study which was expected to be different in the integrated science curriculum program from traditional science curriculum. Students were given the Serve Process Skills Test as a pre-test at the beginning of the school year and were post-tested with same test at the end of the school year. In the experimental group 531 matches were made pre-test to post-test while 398 matches were made in the control group. The experimental group adjusted post-test mean score on the process skills test was significantly higher than the control group. When specific science process skills were examined, the experimental group adjusted post-test mean score was significantly higher that of the control group on identifying experimental questions, identifying variables, designing investigations, and interpreting data. The experimental and control groups showed no significant differences in adjusted post-test means of formulating hypotheses and graphing data.

Gill (2010) attempted to verify points of intersection (POIs) between mathematics and science in the eighth grade Sunshine State Standards (SSS), and to develop a valid and reliable instrument to evaluate these POIs as they were presented in the respective mathematics and science textbooks approved for use in Florida public schools. Content analysis was conducted in the study; the process began with the analysis of the SSS to uncover POIs between mathematics and science; considered effective strategies for presenting these points of intersection in the classroom; and examined the textbooks for a mutually supportive presentation of the POIs between the two domains. First, following guidelines were used for the development of the codebook regarding the quality indicators of the textbook components.

1. Does the textbook identify the standards for both mathematics and science?
2. Does the identified pair of one mathematics textbook and one science textbook use the same vocabulary for the identified POIs?
3. What terms are missing?

4. Are there superfluous terms? Do the superfluous terms in one domain support the second domain?
5. Is each term presented accurately such that it supports cross disciplinary usage?
6. Does the presentation of content follow a logical sequence with consideration for prior knowledge?
7. Is the concept presented through a balance of problem solving activities such that the combination of textbooks provide sufficient mixed practice with a variety of both cover stories and structural design? (p. 43).

After the levels of integration were identified in the Gill's study (2010), the next step was to include an examination of the grade level expectations first for the purpose of determining eighth grade POIs. After that, the Test Item and Performance Task Specifications (TIPTS), in both mathematics and science, for the identified POIs were examined in order to determine the minimum requirements of those integrated concepts and skills based on the assumption that those minimum requirements were included in approved textbooks. The POIs were identified as integrated objectives that filtered for levels of integration. These integrated objectives included;

1. The student solves problems using mixed units of measure related to energy, waves, distance, size and temperature.
2. The student designs an experiment to answer a real-world question.
3. The student assigns variables to be tested by experimental design.
4. The student chooses the appropriate form of statistical analysis to answer a real-world question.
5. The student analyzes and interprets data to draw a conclusion.
6. The student uses formulas to solve problems related to rate, speed, acceleration and volume (p.144).

Then the 8^{th} grade POIs through a review of the eighth grade level expectations was analyzed in both mathematics and science. One of the findings of the study overlap with the related literature that, integration increased as the lesson moved to the center of the continuum where the two disciplines (mathematics and science) became one. This study recommended a more flexible model with three axes such that mathematics, science and integration. Moreover, researcher stated the reliance that many new teachers revealed on textbooks for curricular decisions as an obstacle to integrated curriculum. Therefore she added that it was reasonable to assume that the textbook would present the minimum required curriculum as was garnered from the Test Item and Performance Task Specification documents for mathematics and science for this investigation.

Temiz (2001), in his Master thesis investigate the 9^{th} grade physics curriculum in term of science process skills. He constructed a test assessing science process skills; observing, interpreting data, measuring, using numbers, making space and time relationships, modeling, predicting, classifying, experimenting, defining the variables, hypothesizing, recording data, and inferring. This test was implemented to 80 students in the 9^{th} grade at both beginning and end of the academic year. According to the results, the 9th grade physics curriculum was found to be insufficient in developing students' science process skills.

Taşar, Temiz, & Tan (2002) examined the elementary science curriculum with respect to science process skills in order to answer why the curriculum is unsatisfactory to develop students' science process skills. The framework of Temiz (2001) was adopted for the study; including 12 science process skills; observing, interpreting data, measuring, using numbers, making space and time relationships, modeling, predicting, classifying, experimenting, defining the variables, hypothesizing, recording data, and inferring. The researchers evaluate 576 objectives of elementary science curriculum from the grade levels of 4, 5, 6, 7, and 8 concerning these twelve science process skills. Researchers summarized the findings as;

1. The distribution of objectives in each curriculum was balanced with respect to grade level.
2. The skill of predicting was not included in any objectives of all five curricula, in addition hypothesizing and interpreting data were not included enough in the objectives of all curricula.
3. The most mentioned skill was observing in each curriculum, one of reason can be that there were a lot of objectives addressing students give examples about the concepts.
4. At least thirty-three percentages of objectives does not address any science process skills.
5. There was not any systematic approach observed in each curriculum aiming to develop science process skills of students.

According to the mentioned findings, the researchers implied that science curriculum needs a new systematic approach which addresses science process skills.

2.2.2 The research on analysis of textbook/laboratory manuals on science process skills

Several studies have analyzed the textbooks and manuals used in science classes. Fuhrmann, Novick, Tamir, and Lunetta (as cited in Niedderer, et.al. 2002) developed *The Laboratory Structure and Task Analysis Inventory* (LAI) at 1978. Tamir and Lunetta (as cited in Hanauer, Hatfull, Jacobs-Sera, 2009) coded three high school curricula; biology, chemistry and physics at 1981. The inventory had two sections as Laboratory Organization, and Laboratory Tasks. Laboratory organization part had 14 categories and included subparts namely structure, relation to text, cooperation mode, and simulations. On the other hand, laboratory tasks part had 24 categories and included subparts of planning and design, performance, analysis, and application. The researchers coded every laboratory investigations in the books according to the LAI. Researchers checked categories according to the classification of activities in each investigation for the coding of laboratory organization categories. While coding the laboratory task categories, the researchers checked the appropriate behavioral category according to each statement of a laboratory investigation. The number of the checks were counted, and divided by the total number of investigations and represented this value in percentages. According to their findings, almost all investigations were highly structured and students were seldom asked to a. formulate a question to be investigated; b. formulate a hypothesis to be tested; c. predict experimental results; work according to their own design; d. formulate new questions based on investigation. In addition to these researchers point out that students are “often asked to perform a variety of manipulative and observational procedures and to interpret the results of their investigations”. Tamir and Lunetta (as cited in Köksal, 2008) emphasized that laboratory experiences differentiate according to subject matter, for example inquiry skills in biology are not same with those in physics, even in the same subject area variances occur. The researchers suggested that the LAI can be used in order to evaluate laboratory curriculum, inquiry skills development of students, and selecting laboratory activities and also when developing laboratory activities for inquiry by teachers.

Germann, Haskins and Auls, (1996) used the same tool in their descriptive study to analyze nine biology laboratory manuals to determine how well they promote the basic and integrated science process skills that are involved in scientific inquiry. Researchers reviewed 90 activities selected from the reviewed manuals in 11 topic areas. Each activity included two subsamples of five experimental and five descriptive exercises. Results of this study indicated similar findings with Tamir and Lunetta that these laboratory manuals are organized in a strict way and that students rarely provided with opportunities to pose a question to be investigated, formulate a hypothesis to be tested, predict experimental results, design observation, measurement and experimental procedures, work according to their own design, or formulate a new question or apply an experimental technique based on the investigation they performed. According to seldom representation of science process skills in the laboratory manuals the researchers proposed to modify *cookbook* laboratories to promote students’ inquiry.

Another research using the LAI was conducted by Soyibo (1998) in order to assess level of Caribbean integrated science textbooks' tasks in the practical activities. Soyibo described the structure and *skill* level of the tasks in the practical activities of three sets of books and evaluates the degree to which the suggested students’ practical activities could promote the acquisition of scientific *process skills*. A total of 805 suggested student practical activities were analyzed, coded by a two-person rating team using the LAI. Each person made a tally for the appropriate behavior category of LAI if the instruction to the pupils called for it at least once. These tallies were summed up for each unit of the books. The totals of the tallies for the two coders were obtained for each unit and the three sets of books. The total number of tallies was then divided by the total number of activities in each set of books and expressed as a percentage. According to the findings, all the texts' activities are highly structured (93.00-96.80%) and deductive in approach with an emphasis on low level inquiry *skills* (90.10-97.90%) and many of the activities follow the texts' subject matter; only a few activities precede the texts' subject matter, and student practical activities in the textbooks were highly emphasized (81.00-97.60%). In addition, findings showed that post-laboratory activities were not covered in the textbooks and students were not required to do different tasks at the same time. Researcher concluded that it seems doubtful that the activities could facilitate the development in pupils of the inquiry *skills* they will need in order to carry out open-ended scientific investigations in the future.

A different approach to the definition of scientific inquiry was developed by Chinn and Malhotra (2002). The researchers compared the epistemological and reasoning aspects of professional science with school manifestation of scientific inquiry. 468 inquiry tasks in nine textbooks written for upper-elementary and middle schools and 26 inquiry tasks developed by researchers were analyzed. The school textbooks for hands-on activities were examined and three types of simple inquiry tasks: simple experiments (a single factor experimental design), simple observations (the careful observation and description of an object), and simple illustrations (following a specific procedure) were distinguished. These inquiry tasks were compared to authentic scientific inquiry regarding the cognitive process involved and the epistemological aspects of the tasks. The cognitive processes includes generating research question, designing studies, making observations, developing theories, and studying research reports. The differences in these cognitive processes between in-school scientific inquiry and authentic inquiry are marked. According to the results, in schools students follow directions of textbook and teachers' orders, whereas, scientists function much more as independent problem solvers. In addition, for making observations in schools, students were been addressed straightforwardly research questions without addressing the problems of observer bias. For other cognitive processes explaining results and developing theories, the results were similar: in-school scientific inquiry thought processes are directed toward straightforwardly addressing research questions without addressing the problems of data transformation, experimental flaws, generalizability, theory development, conflicting data and inconsistencies, and more extensive literature. On the other hand, in authentic science the complications and ontological status of any scientific statement is a consistent concern, researchers highlighted.

Moore (2009) used guided inquiry in a series of six laboratory assignments during the instruction of Life Sciences to examine the performance of science process skills of data analysis and conclusion synthesis. Emphasis was placed upon examining the content of the laboratory reports which required students to analyze their experiments and draw a conclusion based upon their findings. According to the results of the study, most students did grasp the desired scientific principles but they had difficulty in formulating a structured and detailed account of their experiences without guidance. Data analysis was the inquiry assessments went from 9% in the pre-inquiry to 88% in the post-inquiry. Students' performance in the laboratory exercises changed with complexity of science concept in the laboratory exercise in a different way. Students were able to formulate a relevant analysis of the data 90 % of the time in the diffusion lab which is the easiest concept, their performance decreased with the complex concepts; -formulating a relevant analysis of the data- 60 % of the time in the osmosis lab and 82 % of the time in the respiration lab and increased with the more complex concept; 87 % of the time in the cell membrane selectivity lab. Students' performance in conclusion synthesis went from 6 % in the pre-inquiry to 88 % in the post-inquiry. The researcher mentioned that students may struggle to formulate a conclusion because they need many opportunities to practice the basic science process skill of observation and inference, as well as more discussions with other students and their teacher.

Aziz and Zain, (2010) compared the science process skills included in the 10^{th}-12^{th} grade physics textbooks content utilized in Yemeni schools. The measuring instrument was a form that included definitions for each element of the SPS supported by examples relevant to the three physics textbooks' content (10th-12th grades**)**. All units and topics except the goals and questions of each textbook were included in the study. According to content analysis, observation (38.4% for 10^{th} grade, 63.94% for 11^{th} grade, 30.2% for 12^{th} grade) was the most emphasized skill in all three textbook content. For the integrated science process skills the maximum percentage differs with the grade level; for 10^{th} grade experimenting had the highest percentage (41%), interpreting had the highest percentage (35.53%) for 11^{th} , and operational definitions had the highest percentage (46%) for 12^{th} grade. On the other hand, hypothesizing was neglected in both the 10^{th} (2%) and 11^{th} (0.66%) grade textbook. For 12^{th} grade textbook controlling variables had the minimum percentage (4.3%). The highest percentage of SPS in the content of the three physics textbooks focuses on BSPS, while the lowest percentage of SPS focuses on ISPS.

Dökme (2005, 2004) evaluated the 6^{th} and 7^{th} grade science textbook published by Turkish Ministry of National Education in terms of science process skills. Observing, classifying, measuring and using numbers, communicating, inferring, predicting, collecting and interpreting data, defining and controlling variables, defining, hypothesizing, experimenting, modeling were selected for investigation in these studies. Observation skill had the highest percentage (89.06%) for the 6^{th} grade science textbook whereas the hypothesizing had the minimum percentage (1.56%). Predicting (14.06%), and classifying (6.25%) were ignored as skill of hypothesizing in the 6^{th} grade science textbook which reveals that there is no systematic distribution of science process skills overall the book. According to results of 7^{th} grade textbook analysis, the skills of observing (50.8%), measuring and using numbers (55.7%), inferring (68.8%) and experimenting (54.1%) were included more than the classifying (8.2%), communicating (22.9%), predicting skills (14.7%) in the activities of the book. According to the results of both studies of her, Dökme suggested that communication, and prediction (and classification) skills should be involved more in the activities of textbooks; the activities should emphasize the skills clearly, i.e., by emphasizing which skill to be used through bold characters. Moreover, she suggested including activities addressing developing students' communication skills by preparing reports of their studies and presenting them others.

Koray, Bahadır, and Geçgin, (2006) identified how much space has been allocated to the science process skills in the chemistry textbooks and curriculums for the grade 9. Content analysis technique was used for the chemistry textbooks and curriculum. Science process skills were divided into three categories; basic skills including observing, measuring, comparing and classifying, recording data, making space and time relationships and casual skills including predicting, determining variables, interpreting data, drawing conclusion and lastly experimental skills including hypothesizing, using data and modeling, making decisions, controlling variables, experimenting and designing experiments. Meeting form was constructed to measure the level of interest in the students towards the chemistry textbook and curriculum. In addition to content analysis of the curriculum and the textbook, structured interview was conducted with students about chemistry course in general and chemistry course textbook. Since there was not a chemistry curriculum approved by the Board of Education, the curriculum mentioned in this study were the chemistry curricula of high schools participated in this study. Findings showed that the most coded skill in both document was the observation skill (20.28% for the textbook and 36.36% for the curriculum). The skills recording data, measuring, and experimenting were the least coded (1.01%) in the chemistry curriculum whereas they were came upon pretty more in the textbook. On the other side, predicting was coded in the curriculum (13.13%) more than it was coded in the textbook. The skills of comparing and classifying (13.04% for the textbook and 20.20% for the curriculum) and interpreting data (13.76% for the textbook and 9.09% for the curriculum) were in balance regarding the frequency of being included in both documents. Neither the skill of controlling variables nor the skills of making decision coded in the documents analyzed in this study. In both documents modeling (2.17% for the textbook, 2.02% for the curriculum) and designing experiment (0% for the textbook and 1.01% for the curriculum) were not included enough. According to the findings, it was concluded that the chemistry textbooks, which were studied in terms of the science process skills, do not fully overlap with the curriculum. It was also stated that the students were interested in the chemistry lesson and the textbook was suitable for their level.

2.2.3 The research on analysis of instruction on science process skills

The practice and improvement of the science process skills in the science classroom has also been focus of a number of science education studies. For example, the studies of Padilla, Okey, and Garrar, (1984); Rubin and Norman, (1992); Tobin and Capie (1980) showed that students can be assisted by the instruction in the process skills; teacher modeling of a specific process skill improves students' attainment of the corresponding skill.

In the Master's research of Ellis (2009) the utility of a T-chart technique for supporting students' scientific reasoning during inquiry based laboratory was investigated. The study took place at a college preparatory high school in an urban Northern California city. The focus group was a high school physics class (n=28) including students of multiple ethnicities and various socio-economic statuses. Students collected and examined data then made claims that answered the research questions. Students' T-charts and conclusions were scored on a rubric, revealing common errors. Teacher reflections tracked class discussions and student behavior. Surveys were given before, during, and after the intervention to assess students' attitudes and science process knowledge. Average rubric scores increased in all rubric categories, showing that the intervention slowly improved students' scientific reasoning skills on inquiry-based laboratory investigations. Most students expressed on opinion surveys that the strategy helped them understand the physics content in labs more deeply. A comparison of students' prior performance in the class against their rubric scores on each laboratory showed a very weak correlation (*Pearson* $r2 < 0.1$), indicating that students of all ability levels were challenged to produce scientific reasoning.

Mandl (2008) identifies the kinds of activities taking place, the level of integration of gardening into standards-based science and other curricular areas, and the presence of scientific process thinking and inquiry. Science process skills addressed in this study were observing, communicating, comparing, ordering, categorizing, relating, and inferring. Surveys were completed by teachers at 59 different elementary schools in Los Angeles Unified School District. Interviews with 13 of these teachers were conducted in the study. The results showed that teachers commonly develop strategies to use the garden as an extension of the classroom, emphasize biology content and foster development of science process skills, and values hands-on, kinesthetic, and inquiry based nature of gardening with children.

Ferreira (2004) conducted a qualitative research to answer the question what roles do a science story, multi-sensorial activities designed to accompany the story, and classroom dialogue associated with the story-all modeled on the Philosophy for Children curriculum-play in the learning processes of a class of fifth graders with regard to the basic science process skills of classification, observation, and inference. Qualitative data was collected during participatory study in a bilingual private religious school in Brasilia for one semester. Twenty-one students from a predominantly middle and upper class social background participated in the study. Interview with students, class reflection sheets, written learning assessments, audiotapes of all class sessions of group discussion, and videotaped of one class session were conducted for data collection. According to findings the story, activities and dialogue facilitated the children's learning in a number of ways. The story modeled the performance of classification, observation and inference skills for the children as well as reflection on the meaning of inference. The majority of the students identified with the fictional characters, particularly regarding traits such as cleverness and inquisitiveness, and with the learning context of the story. The multi-sensorial activities helped children learn observation and inference skills as well as dialogue. Dialogue also helped children self-correct and build upon each other's ideas. Some students developed theories about how ideal dialogue should work.

Smith (1997) investigated the effect of inquiry-based instruction in elementary school science on the frequency and/or appropriateness of student's use of science process skills. In addition, Smith also examined the level of cooperation exhibited by students working in groups to solve problems for the students who had been taught with inquiry-based instructional strategies. The science process skills of observing, measuring, predicting, communicating, forming hypotheses, experimenting, controlling variables, recording data, interpreting data, and applying and generalizing results were measured. Results of analyses showed that experimental groups used science process skills more frequently overall than the control groups.

Zeitler (1981) compared the effect of two different practice method for teaching science process skills in the elementary classroom. The participants of the study were twenty-nine female senior undergraduates who was taking elementary science methods course. There were two treatment groups; microteaching (n=13) in which mini-lessons were created pertaining to the science process skills, and modeling (n=16) in which students put together process skills activities modeled after the instructor used them to teach the skills. Undergraduate teachers taught their lessons to elementary students and then elementary students' science process skills were assessed. According to the results pre-service teachers in both groups made significant and head-to-head gains in acquisition of the science process skills. However, it is also underlined that due to including more process skill activities in lesson plans of microteaching group, students taught by this group scored significantly higher on a process skill test than did the students of modeling group.

2.2.4 Summary of literature review

There are many research studies (Colvill & Pattie, 2003; Flehinger, 1971; Galgam & Grange, 2003; Jimarez, 2005; Padilla, Okey, & Garrard, 1984; Ostlund, 1998; Turpin, 2000) emphasize that a process-based curriculum has a positive effect on the development of science process skills. These studies are mostly experimental; the numbers of qualitative studies focusing on content analysis of the process-based curricula are a few. The qualitative studies (Gill, 2010; Taşar, Temiz, & Tan, 2002) examined the corresponding document by content analysis without constructing a codebook with respect to science process skills.

Several studies analyzes science textbooks with respect to different criteria; regarding to teachers' views (Arslan, Tekbıyık, and Ercan, 2012); perspectives of educational, visual and language (Güzel & Adıbenli, 2011); the criteria for textbook analysis (Demir, Maskan, Çevik, & Baran, 2009). There are many studies considering inclusion of science process skills in the textbooks (Dökme, 2004, 2005; Koray, Bahadır, & Geçgin, 2006, Soyibo, 1998, Chinn & Malhotra, 2002). Similarly, science laboratory manuals are also analyzed by many researchers. For example, Tamir and Lunetta, at 1981 (as cited in Hanauer, Hatfull, & Jacobs-Sera, 2009), and Germann, Haskins, and Auls, (1996) analyzed science laboratory manuals by using LAI. Similarly, Soyibo used same tool to assess the level of Caribbean integrated science textbooks' tasks in the practical activities. According to results of these studies, activities in selected textbooks and laboratory manuals are highly structured in terms of including science process skills.
Research on analysis of instruction on science process skills reviewed in this study is conducted on elementary level (Mandl, 2008; Ferreira, 2004; Smith, 1997; Zeitler, 1981). There is a lack of studies in the literature on secondary school level about how science process skills are included in science lessons. Ellis (2009) investigated the effectiveness of T-chart technique supporting scientific reasoning in the laboratory sessions in high school and concluded that the strategy helped students to understand physics concepts more deeply. However, even this study does not reveal how these skills are included in the laboratory.

There is a lack in the related literature analyzing the gap among curriculum, textbook and instruction in term of science process skills inclusion although the gaps between them are mentioned. Gill (2010) for example, compared the Florida Sunshine State Standards with the textbooks in the area of mathematics and science. Yet, no research revealing the gap among curriculum, corresponding textbooks, and lessons according to science process skills is found.

CHAPTER 3

METHODOLOGY

This chapter presents an overview of the overall design of the current study. The research method is introduced in the first section. Secondly, data sources and sampling are explained for the physics curriculum, textbook and lessons. Data collection process for physics lessons is clarified in the third section. Fourth section, instrument for data analysis, presents the construction of the codebook used in this study. Then, data analysis processes are explained for curriculum, textbook and physics lessons in the fifth section. The reliability and validity issues for the code book are stated in the sixth, ethical issues, profile of the researcher and limitations are placed in the seventh, eighth and ninth sections, respectively. Finally, the procedure of the study is given in tenth section with a timeline figure.

3.1 Research Method and Design

The purpose of this qualitative research is to reveal to what extent science process skills are included in the Turkish 9th physics curriculum, textbook and lessons. Specifically, the study addressed the following research questions:

1. To what extent are science process skills included in the 2007, 9th grade physics curriculum?
2. To what extent are science process skills included in the content of the 9th grade physics textbook which is written corresponding to 2007 physics curriculum and published by Ministry of National Education?
3. To what extent are science process skills included in the 9th grade physics lessons in the chapter of energy?
4. To what extent are 9th grade physics curriculum, textbook and lessons consistent to each other in terms of science process skills?

The research questions were categorized in three parts. Firstly, for the first and the second questions, the procedure of content analysis was constructed. Secondly, 9th grade physics lessons of well-known physics teachers were observed for the third research question. Finally all data gathered from content analysis of curriculum, textbook and observations were compared in order to answer the fourth research question.

Qualitative research is an inquiry process rooted in the understanding of a social or human problem that attempts to build a complex, holistic picture using words and reporting detailed views of informants carried out in a naturalistic setting (Creswell, 1994). Case studies are frequently utilized in the field of education in order to gain a better, detailed understanding of a specific situation and to identify the meaning for those involved in the situation. Cases are not chosen for representativeness, a case can be selected because of its uniqueness or the case may be used to illustrate an issue (Stake, 1995). Case studies are recommended when the item under study is a single social phenomena or a single unit of analysis, such as one policy implementation or one concept (Singleton, Straits, & Straits, 1993). The cases investigated in this qualitative research are the 9th grade physics curriculum, the 9th grade physics textbook published by the Ministry of National Education, and the 9th grade physics lesson. The new high school physics curriculum was developed in 2007 in Turkey. It is different from the other curriculums implemented up to this curriculum in terms of including skills as well as organization of content. The rationale for this case study is to share with the curriculum developers, textbook authors, and physics educators how the 2007 physics curriculum includes science process skills in order to make sound enhancements. This case study is based on content analysis of the physics curriculum, textbook, and physics lessons in the 9th grade.

Content analysis is mainly described as the analysis of written contents of a communication (Fraenkel & Wallen, 2006; Martínez-Gracia, Gil-Quilez & Osada, 2006; Tamir, 1985). Actually, it is a technique that facilitates researchers to study human behavior in an indirect way, through an analysis of their communications in order to make valid and replicable inferences from texts to the context in use (Krippendorff, 2004). Content analysis is used for coding textual information in a standardized way that allows curriculum evaluators to make inferences about the information. It is a method used to reduce many words of text into fewer content categories with particular focus based on explicit rules of coding (Krippendorff, 2004; Weber, 1985). In addition, Tamir (1985) states that content analysis can be useful for the curriculum developers and evaluators in exposing to what extent the objectives are represented in a particular text. Grobman (as cited in Tamir, 1985) mentions the need for a systematic content analysis as a major phase of formative evaluation.

> Although content analysis has been defined in many various ways over the years, it has been perceived as a rigorous form of statistical examination. Being a part to advances in the technology force, content analysis emphasizes the term *systematic procedure* as an important aspect. Lazarsfeld (as cited in Pegues, 2006) expresses that: “The historian, three decades ago, would pick out quotations from newspapers according to his judgment; today, systematic procedures of content analysis for mass communication have developed” (p. 138).

In the current study, content analysis is used to describe to what extent the 9th grade physics curriculum and textbook present science process skills. 9th grade physics lessons were observed and analyzed for the third research question; what extent the 9th grade physics lessons focus on science process skills in the energy chapter. Figure 3.1 shows the research design of this study.

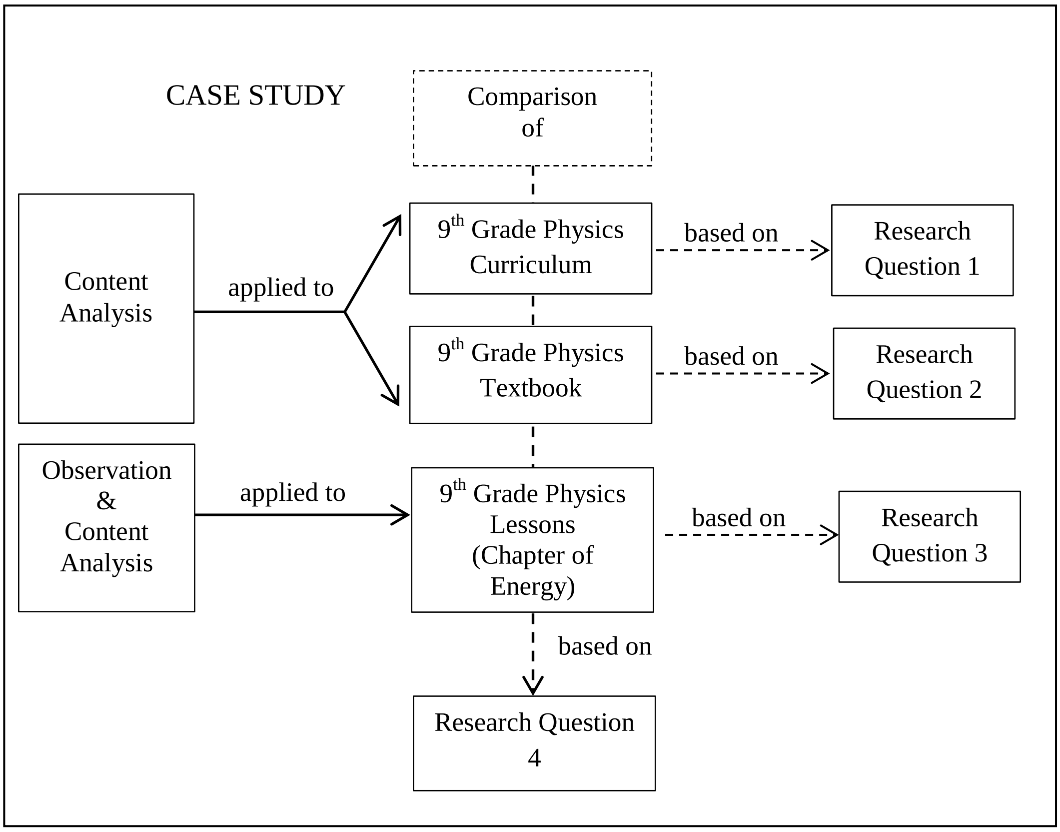


Figure 3.1 Research design of the study

3.2 Data Sources and Sampling

In this content analysis, there are three different samples depending on the three research questions as part of the whole study. The first sample is the 9^{th} grade physics curriculum. The 9^{th} grade physics textbook constitutes the second sample of the study. Finally, the third sample is the 9^{th} grade physics lessons in the chapter of Energy. The following sections explain the sampling procedure for these samples.

3.2.1 The 9^{th} grade physics curriculum

According to the first research question of current study, 9^{th} grade physics curriculum is one of the data sources for the content analysis. There is only one nationwide physics curriculum. Studies to construct framework of the 9^{th} grade physics curriculum started to develop as January 2007 by curriculum developing committee. First draft of the curriculum was finished in June 2007. Teachers from public and private schools, members of Board of Education (the committee in the Ministry of National Education which is responsible for determining the curriculum, textbooks, materials for each courses used in the schools in Turkey), curriculum developers, and experts on measurement and evaluation were involved in the curriculum development process. In order to introduce the 9^{th} grade physics curriculum to teachers from all cities of Turkey, two seminars were organized. After these seminars, the teachers were asked to evaluate the curriculum. Depending on the feedbacks the curriculum was revised. Finally, the 9^{th} grade physics curriculum was published at September, 2007 with the approval of Board of Education. The 9^{th} grade physics curriculum has been used in the high school since September, 2007. Revision progress was continued till August, 2011 with respect to feedbacks of teachers as they implement the curriculum. In this research, final version of the 9^{th} grade physics curriculum which was revised at August, 2011 was taken under study.

The 9^{th} grade physics curriculum (TTKB, 2011) is 104 pages with references and contact information pages. It is consisting of six main parts namely; (1) Basics of the Physics Curriculum; (2) Learning Areas of the Physics Curriculum; (3) Expectations from Textbook Writers and Physics Teachers; (4) Publications; (5) Changes in the Physics Curriculum; (6) Content Organization of 9^{th} Grade Physics Curriculum. In the first part fundamentals of the curriculum are explained; importance of teaching how to access knowledge is mentioned. Daily life contexts of physics are also emphasized in the curriculum. It is requested to use these contexts as a bridge between physics concepts and daily life. In the second part objectives are given in two areas: skill objectives and content objectives. The skill objectives are also divided into four areas; (a) Problem Solving Skills (PSS); (b) Physics-Technology-Society-Environment (PTSE); (c) Informatics and Communication Skills (ICS); (d) Attitudes and Values (AV). Expectations from textbook writers and physics teachers are expressed in the third part of the curriculum. Publications, concerning the curriculum development process of the curriculum development committee, are placed in the fourth part. In the fifth part revision process of the curriculum is explained with their reasons. Lastly in the sixth part, the objectives with expressions, limitations, misconceptions, measurement units, examples for learning and assessment activities are given for all content in detail.

In this study, second and sixth parts of the curriculum are focused: they are "Learning Areas of the Physics Curriculum" and "Content Organization of 9^{th} Grade Physics Curriculum". These parts correspond to skill and content objectives, in brief. In the second part, as mentioned above, there are four components; (a) Problem Solving Skills (PSS); (b) Physics-Technology-Society-Environment (PTSE); (c) Informatics and Communication Skills (ICS); (d) Attitudes and Values (AV). PSS include scientific process skills, creative thinking skills, critical thinking skills, analytical and spatial thinking skills, data handling and computational operations, and higher order thinking skills. A systematic approach is presented for solving a problem by integrating these skills altogether. Three general objectives stated for these skills are as follows: Students should be able to (a) identify a problem to be investigated and make a plan to solve the identified problem; (b) Make an experiment to solve the identified problem and collect data, (c) Process obtained data to solve the problem and interpret them. PTSE skills include objectives that are related to understanding, interpreting and analyzing relationship among physics, society, technology and environment. ICS take account of informatics (information technologies), communication and basic computer skills. AV contains self-control and self-development skills, organization and working skills and scientific attitudes and values.

The sixth part, "Content Organization of 9th Grade Physics Curriculum", covers content objectives in chapters for physics contents in such a way that; 9th grade physics content is chosen with attention to the fact that all students may face these physics concepts in real life. 9th grade physics course is taken by all high school students. After this grade, some of students do not take physics courses anymore because it becomes an elective course for other levels. Contents in 9th grade physics curriculum are "Nature of Physics", "Matter and Properties", "Force and Motion", "Energy", "Electricity and Magnetism" and "Waves".

Skill objectives are associated with content objectives in the curriculum. The physics curriculum is modeled as a fruit tree, which is shown in Figure 3.2 (TTKB, 2011). In this model, tree refers to student, roots refer to skill objectives and fruits refer to the content in the curriculum. Water droplets are used to show that outcomes of skill and content objectives support and feed each other. According to this model, students are engaged with skill and content objectives which are expected to be useful in daily life. Thus, students are able to integrate content knowledge learned by using these skills for solving daily life problems.

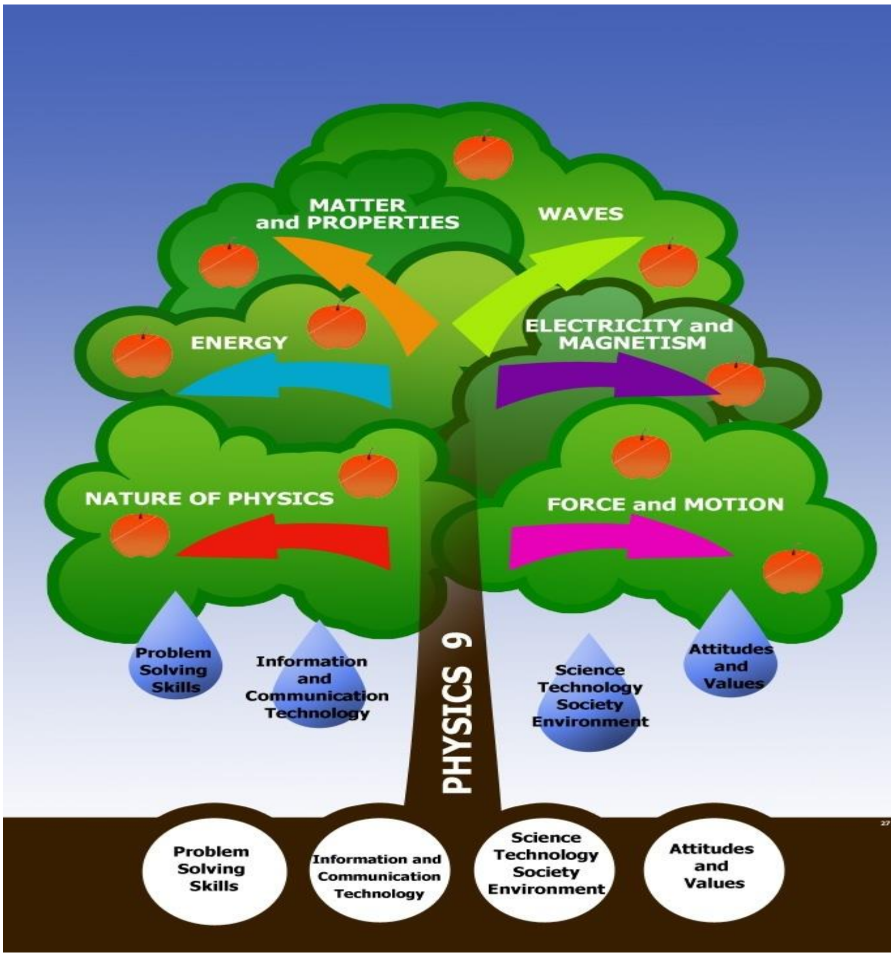


Figure 3.2 Three model of the 9th grade physics curriculum

3.2.2 The 9th grade physics textbook

The second research question of this study addresses content analysis of 9th grade physics textbook which was written with respect to 2007 9th grade physics curriculum. 9th grade physics textbook published by the Ministry of National Education was the first and the unique textbook for the first year of application of the curriculum. It was approved on 3rd June 2008 by Board of Education. Another 9th grade physics textbook was approved in 2011 by the committee to be used in the schools. The textbook published by the Ministry of National Education has been used for longer time than the secondly approved one, so it had time to be revised. It has been revised for many times since 2008 according to the feedbacks from teachers and Board of Education. Hence the book published at 2010, last version of the textbook was chosen for this study. Moreover, the chosen textbook is the one widely used at the secondary schools in Turkey.

In this study third edition of the book published at 2010 was chosen to be analyzed. Because it was the current press when the textbook analysis took place in the research. The book has six chapters which are; (1) Nature of Physics, (2) Energy, (3) Properties of Matter, (4) Force and Motion, (5) Electricity and Magnetism, and (6) Waves. All chapters were analyzed with respect to the SPSCB.

3.2.3 The 9th grade physics lessons

For the aim of answering the third research question of the present study, 9th grade physics lessons are analyzed as the data source. In order to decide sample for physics lessons, teachers were taken into account. Teachers who think that she/he follows the curriculum by means of content and skill objectives were included in this study. In this section, the sampling procedure for physics teachers is explained.

3.2.3.a Physics teacher selection for the physics lessons

The sample for physics lessons was selected by extreme sampling which is a type of purposeful sampling. Extreme sampling focuses on cases that are special. The findings of research on extreme cases can provide an understanding of more typical cases (Gall, et al., 2003). The physics teachers, because of being the implementers of curriculum played crucial role in determining the lessons for the study. In this study, teachers who implement the physics curriculum by both following the content of curriculum and focusing on the skill objectives, were sought to be the special case. After a detailed procedure was conducted, three physics teachers were decided to be included in the study. This process is expressed in the following paragraphs.

For the process of selecting teachers whose lessons would be observed, two stage selections were conducted. Firstly the 9th grade physics teachers in Ankara were determined by snowball sampling technique. Snowball technique is choosing a few people who can recommend other people who can recommend still other people that might be worthy participants for a study (Gay & Airasian, 2000). The teachers accessed were asked if they follow the 9th grade physics curriculum focusing not only the content but also skills objectives. Teachers who told that she/he is not addressing the objectives for skills in the curriculum were eliminated. Seventeen teachers were accessed and then, the teachers who accepted the observation of their class were visited in their schools for clarification about aim of both the study and observation. Ten teachers agreed to participate in the study after having face to face meetings and meetings on phone. These teachers are from different types of schools; five teachers from Anatolian high school, two teachers from vocational high schools, two teachers from science high school, and one teacher from public high school took part in the study. Teachers were asked to videotape their physics lessons; some teachers did not accept this request. In lessons of teachers who did not accept her/his lessons videotaped, researcher took notes on Science Process Skills Observation Sheet (SPSOS). Lessons of these ten teachers were observed by the researcher during two or three weeks. The aim of these observations, in the first stage, was to eliminate teachers according to what extend science process skills were included in their 9th grade physics lessons. Teachers were given Science Process Skills Questionnaire (SPSQ) in order to determine how extend they think they include SPS in their lessons. However making observations of lessons makes researcher understand how they include SPS in the classroom setting and make decision about the physics teacher to be included for deep investigation. Table 3.1 shows duration of the observations focus on the content of the lessons and type of the schools.

Table 3.1 Details about observation of physics lessons for stage 1

Teacher	Dates of Observation	Time of Observation	Duration of Observations	Video Record	Chapter	School Type
T1	18.02.2013	08:15 - 09:55	70'	Yes	Energy	Anatolian High School
	25.02.2013	08:15 - 09:55	70'	Yes		
T2	19.02.2013	08:55 - 09:40	40'	Yes	Energy	Anatolian High School
	22.02.2013	08:55 - 09:40	40'	Yes		
	26.02.2013	08:55 - 09:40	40'	Yes		
T3	20.02.2013	08:00 - 09:40	64'	Yes	Energy	Anatolian High School
	27.02.2013	08:00 - 09:40	40'	Yes		
T4	07.02.2012	09:10 - 10:50	70'	No	Energy	Anatolian High School
	14.02.2013	09:10 - 10:50	60'	Yes		
	21.02.2013	09:10 - 10:50	73'	Yes		
T5	14.02.2013	12:20 - 14:00	40'	Yes	Force and Motion	Anatolian High School
	21.02.2013	12:20 - 14:00	70'	Yes		
	28.02.2013	12:20 - 14:00	40'	Yes		
T6	14.02.2013	14:55 - 16:25	70'	Partial	Force and Motion	Vocational High School
	21.02.2013	14:55 - 16:25	70'	No		
T7	25.02.2013	12:30 -13:10	36'	Yes	Energy	Science High School
	04.03.2013	12:30 -13:10	40'	Yes		
	11.03.2013	12:30 -13:10	37'	Yes		
T8	01.03.2013	12:00 - 13:40	64'	Yes	Energy	Vocational High School
	08.03.2013	12:00 - 13:40	66'	Yes		
T9	18.02.2013	10:45- 11:55	70'	No	Energy	Science High School
	25.02.2013	10:45 - 11:55	70'	No		
T10	21.02.2013	14:30 - 15:15	30'	No	Energy	Public High School
	28.02.2013	14:30 - 15:15	30'	No		

For the second stage, in order to be special cases of content analysis the number of teachers needed to decrease to two or three. The Observation Sheet; SPSOS (Appendix D) is prepared by the researcher in the light of SPSCB. Physics lessons of ten teachers were observed during periods mentioned in Table 3.1. After observations were completed for the first stage, teachers were given SPSQ (Appendix E) asking personal information with demographic questions, teaching experience, and how often they think they include science process skills practices in their physics lessons especially in the Energy chapter. Observations were watched for many times and analyzed according to SPSCB and questionnaires were analyzed according to teachers' answers with the intention of deciding teachers who include SPS more than others do. The results of observations and SPSQ are given Appendixes D and E, respectively.

Videotaped observations and notes taken during observations were coded according to SPSCB and total number for codes was divided into number of hours observed for each teacher. Table 3.2 presents the total SPS codes and duration of observations in hour and the ratio of them.

Table 3.2 Results of observations in the first stage

	Teachers									
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Observation duration	4 h.	3 h.	3 h.	5 h.	4h.	3 h.	3 h.	4 h.	4 h.	2 h.
Total SPS	20	32	44	29	47	10	22	29	12	15
SPS/hour	5	10.7	14.7	5.8	11.8	3.3	7.3	7.3	3.0	7.7

According to Table 3.2, ratio of SPS per hour of teachers T2, T3, T5 are more than the ratio of others. SPSQ was also considered in the process of deciding teachers for second stage of sampling. The frequency level for inclusion of SPS was asked in the questionnaire, and average frequency level was calculated due to teachers' answers. Table 3.3 displays the average frequency value for all teachers.

Table 3.3 Results of questionnaire in the first stage

	Teachers									
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Average frequency value	3.0	3.2	3.7	3.0	3.2	3.2	2.8	3.0	3.0	3.1

(1: Rarely, 2: Occasionally, 3: Periodically, 4: Usually)

The average frequency value of SPS in physics lesson especially in Energy chapter is almost same for all teachers. Teachers think that they include SPS periodically in their lessons. Therefore, results of observations in the first stage are more effective than the questionnaire in decision making process. Nevertheless, teachers who are indicated by results of observations have higher values for frequency level of SPS inclusion although the differences are small.

Three physics teachers were selected according to the results of observations and SPSQ. The lessons of two teachers were observed during the Energy Chapter. The other teacher was observed during the Force and Motion Chapter in the first stage of observations. When she passed to the Energy Chapter, observations started again and continued until the end of the chapter. Each lesson was videotaped in order be more accurate for content analysis. Table 3.4 shows the details about the weeks, dates, time and duration of observations of three teachers.

Table 3.4 Details about observation of physics lessons for stage 2

Teacher	Dates of Observations	Time of Observations	Duration of Observations	Video Record	Chapter
T2	19.02.2013	08:55-09:40	40'	Yes	Energy
	22.02.2013	08:55-09:40	40'	Yes	
	26.02.2013	08:55-09:40	40'	Yes	
	01.03.2013	08:55-09:40	33'	Yes	
	05.03.2013	08:55-09:40	37'	Yes	
	08.03.2013	08:55-09:40	40'	Yes	
	12.03.2013	08:55-09:40	40'	Yes	
T3	20.02.2013	08:00-09:40	64'	Yes	Energy
	27.02.2013	08:00-09:40	40'	Yes	
	06.03.2013	08:00-09:40	80'	Yes	
	13.03.2013	08:00-09:40	80'	Yes	
	20.03.2013	08:00-09:40	80'	Yes	
	27.03.2013	08:00-09:40	70'	Yes	
T5	27.03.2013	08:15-09:55	70'	Yes	Energy
	03.04.2013	08:15-09:55	70'	Yes	
	05.04.2013	11:00-11:45	35'	Yes	
	12.04.2013	11:00-11:45	35'	Yes	
	16.04.2013	10:05-10:50	35'	Yes	
	17.04.2013	08:15-09:55	70'	Yes	
	19.04.2013	11:00-11:45	35'	Yes	

3.2.3.b Profile of teachers

In this section, information about three teachers is presented. The teachers are denominated as T2, T3 and T5.

Teacher denoted as T2 is male, 43 years old. He graduated from Faculty of Education, Department of Physics Education with a master degree. He had worked at a technical high school for 4 years, an elementary school for 5 years, an Anatolian vocational school for 3 years and Anatolian high school for 8 years. Totally he has 20 year experience on teaching physics. He had taken three in-service seminar organized by Board of Education five days at 2009, two weeks at both 2010 and 2011.

The second teacher called as T3 is male, 38 years old. He has Bachelor Degree from the Faculty of Art and Science, Department of Physics. He has 11 years’ experience on teaching physics working at a public high school for 2 years, an Anatolian teacher high school for 1 year and Anatolian high school for 8 years. He had taken three in-service seminar organized by Board of Education five days at 2009, ten days at both 2010 and 2011.

The third teacher called as T5 is female, 43 years old. She has Bachelor Degree from the Faculty of Art and Science, Department of Physics. She has 23 years' experience on teaching physics working at a vocational school for 3 years, at a public high school for 11 years, an Anatolian high school for 9 years. She had taken five in-service seminar organized by the Board of Education fifteen days at both 2010 and 2011, twice for a week at 2011 and three days at 2012.

3.3 Data Collection

There are several methods of collecting data; for example observation, document reviewing, narratives, life histories, and interviews in qualitative research (Marshall & Rossman, 1995). In this study, for the first and second research questions, the data were already ready the 9th grade physics curriculum and the 9th grade physics textbook. The data for the third research question were collected by SPSQ and observation of physics lessons. In this part, data collection instruments are introduced and information observation is supplied in detail; aims and properties of them are presented.

3.3.1. Science process skills questionnaire

The SPSQ was prepared by the researcher for the aim of determining teachers' thoughts of how often they use science process skills in their Energy lessons. In the first part of observation, ten teachers accepted to take part in the study. Afterwards, the physics classes of these teachers were observed for two or three weeks by the researcher. Three teachers were decided to be observed as cases for the second part of observation in order to make in-depth investigation. One purpose of this study was to reveal how science process skills are exposed in the physics lesson and compare it with the results of the curriculum and textbook. Teachers are the organizers of the lessons; they shape the activities in the classroom. In order to observe physics lessons including science process skills, it was essential to find out physics teachers who aim to include science process skills in their lessons as it is in the curriculum. Thus, the questionnaire was developed to help to select the teachers who implement the curriculum appropriately and include science process skills in their lessons. The purpose of the questionnaire is to reveal how frequently teachers think that they focus on science process skills in physics lessons. Beside science process skills, it is important for the study whether teachers follow both 9th grade physics curriculum and the 9th grade physics textbook. Another main purpose of the questionnaire was to determine the teachers who claim that she/he follows both 9th grade physics curriculum and the 9th grade physics textbook in the physics lessons.

The questionnaire includes seven demographic questions of teachers' background in the first part. In the second part, there are ten short answer questions asking teachers' professional information including questions also focusing on the chapter of energy. The third part includes thirty-nine, 4-point Likert-type statements standing for the frequency level of each activity. The questions in the third part were prepared according to the science process skills literature. However it does not contain detailed questions for each skill as it is the case in the codebook. The purpose of this questionnaire is to determine the teachers who claim that s/he focuses on science process skills in their physics lessons. Since the quality of the lesson or to what degree the teachers focus on these skills is not focal point of the questionnaire, detailed questions are not included in the questionnaire. Nevertheless, each science process skills contain at least three different questions indicating the level of the skill; information based, process based or skill based.

Another reason of constructing thirty-nine statements on science processes for the questionnaire is the feasibility of the questionnaire. It was aimed to prepare the questionnaire long enough to cover all necessary statements for science process skills and short enough to be filled without undue amount of time and energy.

3.3.2 Interview sheets

The method of interviewing is useful for the study to understand how the teacher is aware how s/he is focusing on science process skills. The interviews with teachers were used as conclusion triangulation for observations. The purpose of interviewing with teachers is to validate the findings that the researcher reached.

The main structure of the interview questions was appeared after all observations were coded. Because the findings of each teacher were different from each other, the interview sheets were prepared individually. The interview sheets were composed of two sections; a table and descriptions of details. SPS that teachers emphasized and neglected in lessons were summarized in a table. These tables are showed to teachers and asked whether they are meaningful to them. Then, each skill was discussed one by one according to information given in the second part of interview sheets.

Interviews were recorded according to permission of the teachers. It took almost one hour for each interview. Researcher met with teachers where they wanted, and tried to make them feel comfortable. After interviewing, each record was transcribed and used for the validation of physics lessons' observations.

3.3.3 Observation

In this study, 9th grade physics course setting, students and teacher were observed by the researcher. Observation was held on at two stages. Firstly, physics lessons of ten teachers were observed for two/three weeks in the second semester of the academic year 2012/2013. Then, after analyzing the observation of ten physics teachers' lessons with respect to SPSPC, the observations went on with three of teachers. The observations of second stage were also done in the second semester of the academic year 2012/2013. The classes were observed during the chapter "Energy" which is the first chapter of second semester with respect to 9th grade physics curriculum. However, in some classes the observation started before the "Energy" chapter, in this way teacher and students got used to the camera. Observations of the chapter "Force and Motion" were not analyzed in this study. Only the records on "Energy" chapter were used for content analysis. There are two physics classes in a week for the 9th grade in each school's weekly lesson schedules. Each class took forty five minutes;

the detailed information about the duration of observation in each class was given at Table 3.1 and Table 3.4.

The researcher was a non-participant observer. The role of the researcher was just to observe what is conducted in the lesson. The researcher was introduced to the students by each teacher before the observation started. The researcher explained the purpose of the study and the purpose of observing the physics lessons to the students of each class participated in the study. It was emphasized that researcher would record the lessons without disturbing the students and the teachers.

When many behaviors to be recorded occur at the same time and/or closely together, it is helpful to video record the setting aimed to be observed (Bell, 2005). In addition, video recorded data provide contextual data when the study deals with real people in real situations, doing real activities. Video recording of the events enables researcher replay the needed moments several times. Hence, missing data can be reduced in this way which is very important for the validity of the qualitative study. For this reason, a portable video camera was used during the observations of the physics classes.

During the video recording phase of implementation, the researcher paid attention not to distract teachers and students. In order to achieve this, the researcher sat in the back of the class taking the students and teacher forefront. In addition, the researcher set the equipment during the break time just before the lesson starts in order not to distract the lesson. Similarly researcher left the classroom in the break time.

The information source in the observation was mainly the teacher; focusing the teaching activities including science process skills and their practices. The other source was the students in the learning setting; focusing the participation to the class activities, interaction with teachers and each other.

3.4 The Instrument for Data Analysis

The specific nature of the research question in this study needs the development of a new instrument. Therefore, a detailed codebook was developed by the researcher for recognizing science process skills in text and in learning setting. In this section, the SPSCB is introduced which is the only instrument for data analysis in this study. The development procedure is explained in detail in the following sections. Information about experts, who evaluate the code book, is given in the first subsection. Unit of analysis and context units are explained in the second and third sub section. In the fourth one, the processes of recognizing the SPS are clarified.

3.4.1 The science process skills code book

Before starting to prepare the SPSCB, literature was reviewed about SPS in order to have an idea of how these skills are included in a text and in learning setting. Each skill was defined specifically with respect to the literature. It was difficult for some science process skills to make distinction between them. In order to understand the science process skills, books (Bell, 2008; Carin & Bass, 2001; Dorothy, 1993; Friedl, 2005; Harlen & Qualter, 2009; Lawson, 2010; Llewellyn, 2007; Martinello & Gillian, 2000; Moyer, Hackett and Everett, 2007; Ostlund, 1992; Rezba, et al., 2007; Ronald, 1970; Schaffer, 2006; Wallace Cave and Berry, 2009; Wolfinger, 2000) related to science process skills were read in detail. Especially the part of the books stating the objectives of developing science process skills had an important role in understanding the small differences among the skills. Alongside the dictionary definitions of skills, it was important to define how to recognize them in a text and learning setting.

It took one year to end up with the final version of the SPSCB. Firstly, all keywords for each skill were extracted from the literature about science process skills. A table including brief definitions of science process skills with keywords was prepared (Appendix I). It was not enough to make clear identification of science process skills. Detailed explanations about the process skills were needed. By analyzing PhD studies (Binns, 2009; Phillips, 2006; Wang, 1998) which include the process of constructing a codebook, the organization and presentation style of the code book became clear to the researcher. Then the frame of the code book came into view including detailed definitions, expressions of how to recognize the skills. After constructing the first draft of the code book (Appendix H), it was given to three Ph.D. students in the Faculty of Education at Middle East Technical University to take feedback. The evaluators were asked to check the clearness; clarity, sufficiency of both definitions and expressions of science process skills. The evaluators recommended to revise some unclear statements and to be consistent in using phrases. However, the important recommendation that change the style of the code book was that "*explain how to use the code book*"; means add a part called as rules of analysis. Through a more detailed literature review, the content of the codebook was extended. To develop the SPSCB, beside the literature about science process skills, guidelines for procedure of content analysis were reviewed. For example, Procedures for Conducting Content Analysis of Middle School Science Textbook which was written by Chiappetta, Fillman, and Sethna in 2004 (as cited in Phillips, 2006) was reviewed for better understanding of how to construct the instrument for content analysis. As a result of detailed literature review, the second draft of the codebook was consisted of four main parts namely; (1) Introduction; (2) Unit of analysis; (3) Rules for analysis; and finally (4) Categories for Science Process Skills with definitions, codes, and examples from the textbook.

The second draft of the code book was also given to same evaluators; doctorate students for feedback. They were again asked about the clarity, and sufficiency of the new parts which were added during revision. Meanwhile as a pilot study, the 9th grade physics textbook was coded by the researcher with respect to the second draft of the code book. What was realized during this pilot study was that the codes were needed to be distinguished according to the type of information they have like being knowledge-based, and skill-based. In the light of the literature on taxonomies the codes were categorized as (1) "knowledge based" which was also separated as (1.a)"declarative knowledge" and (1.b) "process knowledge" and (2) "skill based" which was divided as (2.a) "task based skills" and (2.b) "transferable skills".

Feedback from evaluators for the second draft was not effective for this time since the main part of second draft was similar to first draft. The experience of the researcher during pilot coding influenced herself to revise the codebook and end up with the first version. By grouping the codes under the sub categories as mentioned above, the first version of the code book was attained (Appendix J).

Following the construction of the first version, the experts who have been working on science process skills were asked to evaluate the code book. The experts were asked to evaluate the code book according to SPSCB evaluation form prepared by the researcher (Appendix L). The pattern of evaluation form was prepared accordingly to the parts of SPSCB. For example introduction part has its own questions about clarity, quality and adequacy. Moreover, a checklist which shows each code to be criticized with respect to clarity, quality, adequacy, being limited, being in the right category, etc. was included the form. The questions for unit of analysis, context unit, and codes in the form were constructed with respect to literature on content analysis, investigating answers for how unit of analysis should be decided, how codes should be defined, etc.

The feedback given by nine experts were analyzed item by item for each part. Detailed summary for evaluation of experts' opinion is given in Appendix M. Nevertheless, here are some feedbacks and important suggestions of them which cause specific modifications in the code book parts in the codebook; introduction, unit of analysis, categories, and rules of analysis, respectively.

Almost all experts (seven of them) agreed that the aim of the code book is given clearly, sentences are open and clear enough and the given information is enough in the introduction part. However, three experts criticized the introduction part being insufficient because of not highlighting the importance of science process skills. Due to this criticism, importance of science process skills was emphasized with adding a part stating "developing science process skills improve students' skills of problem solving, critical thinking and decision making."

The second part, unit of analysis was consisting of two sub-parts, namely context unit and recording units. Each part of the textbook like "Let's Investigate", "Activity", and "Problem Solving" was defined as context unit. Paragraph or paragraphs which are coherent were also defined as context unit. Three experts suggested elaborating the definition of paragraph and paragraphs in order to make clear the distinction between two of them or combine them. Since it is confusing to define the meaning of being coherent, paragraph and paragraphs were combined.

In the second sub-part there were tiny changes made due to the suggestions of expert. The statements "table which students are expected to fill", "figure which students are expected to use, interpret, etc." and "photograph which students are expected to use, interpret, etc." were added to clarify the recording units table, figure, and photograph.

In spite of the fact that the experts did not criticize the context unit, the supervisor advised to the researcher to redefine the context unit. Because, the parts of the textbook may not be sufficient to decide a unit of recording is a science process skills code or not. There need to expand the context unit, so context unit was defined part of textbook for each main objectives of curriculum. The borders between the parts written for each main objective were determined and mentioned in the final version of the code book.

The third part of the code book is the categories for SPS. Experts agreed on the clarity, suitability, relevance of the rules of analysis in the fourth part. However, small modifications were done like changing the verb “read the codebook until you are familiar to it” with “read the codebook until you comprehend the codes.”

Not only the feedbacks but also discussions with the supervisor contribute to revision of SPSCB. The evaluation of the experts’ critics and recommendations were reflected on the code book for the final version. The suggestion for the introduction part “emphasizing the importance of science process skills” also affected the codes. A new code was added to each category stating the importance of science process skills in science. The last version of SPSCB in Turkish (Appendix A) was accomplished after all these procedure done and it was used in data analysis process. It was also translated into English (Appendix B), however it is not a professional translation.

SPSCB was prepared firstly for the textbook and then it was modified for the curriculum. Categories for SPS are the same; there are small differences in the rules of analysis depending on the type of the document. The context units are different in two documents and examples are not included for the curriculum one. The code book for the curriculum is given in Appendix C; only the different parts are presented.

In the following sections, firstly profiles of experts are explained. Then units of analysis and context unit constructed for the code book are described respectively. Next, the process of recognizing the SPS is expressed.

3.4.1.a Profiles of the experts

The SPSCB was sent to nineteen experts from different universities in Turkey. Only nine of them filled the evaluation form about the code book, gave feedback on the code book and sent the form back. All experts except one are academicians from different universities of Turkey. Four associate professors, two assistant professor, two researcher assistant, an one physics teacher, who is also doctorate student, evaluated SPSCB with respect to SPSCB evaluation form (Appendix J). All experts are academic member of a university and have studies on science process skills.

One of the associate professor experts has her PhD, Master and Bachelor degrees in the area of Elementary Science Education. Her research area is mainly about creative and critical thinking, problem solving skills in education. She also has articles about science process skills focusing on how they were included in chemistry curriculum and textbook.

One of the experts is an associate professor at the Department of Curriculum and Instruction of the Faculty of Education. Her doctoral dissertation is about the effect of project-based learning on creative thinking, problem solving skills of elementary students. In addition, she has many publications mostly on problem solving skills, assessment and evaluation; alternative assessment technique; portfolio. She has a publication offering V-model and I diagrams as effective tools to develop process skills at science laboratories.

Another associate professor expert has her all degrees on secondary school science and mathematics education; physics education. She has studies about instrument development, and determining problem solving skills level of elementary students.

The two assistant professor experts are asked to evaluate SPSCB, since they studied on science process skills in their Ph.D.'s. One of them also examined the physics curriculum regarding to science process skills in his master thesis and has many publications especially on science process skills totally and specifically on some of them.

The teacher, who is doctorate student, is making content analysis for his research. Before being a teacher at school, he was a research assistant at a university.

Other research assistant experts of this study are doctorate. students. One of them is also making content analysis for her Ph.D.

Beside seven experts having experience about science process skills and/or content analysis, two of the experts have experience neither on science process skills nor content analysis. One of the associate professor experts has no studies on science process skills, he was asked to be the evaluator of SPSCB he had his doctorate about assessment and measurement and statistics. He was asked to evaluate the code book through assessment aspects.

The other expert, graduated from the Department of Mathematics, has a master degree on mathematic education and studying mathematics education for her Ph.D. Her research is totally different from this study. The aim of asking her to evaluate the SPSCB is to understand the clarity of the code book for a person from unrelated area.

3.4.1.b Unit of analysis

Krippendorff (2004) defined coding units as "units that are distinguished for separate description, transcription, recording, or coding" (p.97). Units are wholes that analysts distinguish and treat as independent elements. In order to make meaningful outcome, the objects that are counted must be distinct. For example, it makes sense to count words or sentences but not the text. Meanings are also countable when it is possible to make a distinction among meanings and ensure that one does not depend on another.

The units are aspects of text that convey messages to the reader including complete paragraphs, one or more than one sentence(s), questions, figures with captions, tables with captions, pictures with captions, and each complete step of an activity. Each of these text parts are referred to as a unit of analysis (Chiappetta, Fillman, & Sethna, 2004). In preparing coding unit each part of the text which can convey message addressing science process skills was taken into account. The coding units for content analysis of each text included in this study were decided as:

1. Complete paragraphs,
2. One or more than one sentence(s),
3. Questions,
4. Each complete step of an activity,
5. Tables with captions,
6. Figures with captions,
7. Pictures with captions.

3.4.1.c The process of defining context unit

Context units are units of "textual matter that set limits on the information to be considered in the description of recording units" (Krippendorff, 2004, p.101). Unlike coding unit, context units do not need to be independent from each other, they can be related or even overlapped. The main idea of context unit is that it helps analysts in identifying coding units by determining the big frame of the unit. Although context units generally enclose the coding units they help to identify, they may go before the occurrence of a coding unit or be located elsewhere, such as in footnotes, indices, glossaries, headline, or introduction. In this study each part included in the 9th grade physics curriculum and in the 9th grade physics textbook was defined as context units. Each part defined and described with the examples from the sources in the SPSCB.

The size of the context unit depends on the research question and the type of information which has been sought for. So, there is no rational limit to the size of context units. Generally, larger context units conclude more precise and semantically more satisfactory accounts of coding units than do smaller ones, but they also require more effort on the part of analysts (Krippendorff, 2004). In this study the size of each context unit was different from each other depending on the size of each part in the curriculum and textbook. However, it is also emphasized in the codebook that when it is difficult to decide for the coding unit, analyst can move to the previous or next context unit.

3.4.1.d The process of recognizing the science process skills presentation

Primarily, books related to teaching and assessing science process skills (Bell, 2008; Ostlund, 1992; Rezba et al., 2007) were reviewed in detail. The idea how science process skills can be included in a text and in a learning setting was discovered through reading the objectives written for each skill in these books. Activities included in the books were analyzed to conclude general definitions for recognizing the skills.

There are eleven science process skills which were divided into two; basic science process skills and integrated science process skills included in the codebook. Observing, measuring, inferring, classifying, predicting, and communicating scientifically are in the first group which is named as basic science process skills. The second group; integrated science process skills are hypothesizing, defining and controlling the variables, experimenting, collecting and interpreting data, and modeling. Each skill was explained in the SPSCB.

While determining science process skills two dimensions were taken into account. The two dimensions were named as "knowledge-based" and "skill-based". Codes for each skill in the code book were collected under these two dimensions. "Knowledge-based" codes were divided into two domains; "declarative-knowledge" and "procedural-knowledge". Skill-based codes were also separated into two domains as "task based skills" and "transferable skills". Table 3.5 summarized the dimensions and the category for a science process skill, and Table 3.6 is an example of the organization for codes of classifying in the SPSCB.

Table 3.5 Summary of the dimension of skills

Dimensions			
Knowledge-Based		Skill-Based	
Declarative-Knowledge	Procedural-Knowledge	Task Based Skills	Transferable Skills
Learner is informed about facts, generalizations and vocabulary terms. "what" of human knowledge	Leaner is informed about procedure of the skills; explained "how-to" perform the skills.	Learner is given a defined task to perform the skills.	Learner is expected to transfer the skills form one phenomena to another one.

Table 3.6 Organization of codes for a skill; Classifying

Domains	Dimensions	Code	Explanation
Knowledge-Based	Declarative Knowledge	LKD1	States that classification is one of science process skills.
		LKD2	States that scientist classifies objects, events while doing science.
		LKD3	Explains the importance of classification in science.
	Procedural Knowledge	LKP1	Gives information about the skill; classification.
		LKP2	Explains how to classify the objects or events.
		LKP3	Explains important points considered while classifying the objects or events.
Skill-Based	Task-Based Skills	LST1	Makes students identify the common characteristics of the objects/events. Makes students identify the different characteristics of the objects/events.
		LST2	Asks students make classification based on the information given. Asks students determine the common characteristics of a well-known classification. Asks students determine the different characteristics of a well-known classification.
	Transferable Skills	LSR1	Asks students classify the objects or events with respect to the criteria which they determine.

3.5 Data Analysis

Data analysis is the process of systematically searching and arranging all data collected for the study. It involves interpreting and making sense of the accumulated data in order to increase the understanding of them and to enable the researcher to present what was discovered (Bogdan & Biklen, 1998). In this study, 9^{th} grade physics curriculum, textbook published by Ministry of National Education, and physics lessons were aimed to be analyzed with respect to science process skills. Content analysis was conducted to all data gathered in the study. In other words, all types of data were analyzed by coding; texts in the 9^{th} grade physics curriculum, textbook, transcriptions of observation records, and interview records.

In the analysis of all data, a qualitative data analysis program; NVIVO 10 was used. Using a computer software package for analysis is helpful because of availability of keeping huge amount of data in order and it also eases of manipulating the codes at different times during the analysis, and availability of coding video-records. Moreover, the program allows analyst make comparison among the sources.

3.5.1 Data analysis of the curriculum

Content analysis was conducted to 9th grade physics curriculum in this study. In this section, the procedure of this content analysis in explained. Obtaining the curriculum, making it feasible for analysis, determining unit of analysis and procedure of analysis are included in this section.

3.5.1.a Obtaining the document

The 9th grade physics curriculum (TTKB, 2011) was attained in electronic format (PDF) from the webpage of Board of Education. The curriculum converted from PDF to Word document and saved page by page in order to upload to NVIVO. It was also possible to upload the document as one word document, however when the pages were uploaded separately it was easy to follow codes on each page.

3.5.1.b Determining the unit of analysis

Units of analysis in coding the curriculum were defined as paragraph, sentence(s), questions, each skills objective, content objective and explanation for objectives. Moreover, each part in the curriculum was considered as context unit with sub-parts separately: (1) Basics of the Physics Curriculum, (2) Learning Areas of the Physics Curriculum, (3) Expectations from Textbook Writers and Physics Teachers, (4) Publications, (5) Changes in the Physics Curriculum, (6) Content Organization of 9th Grade Physics Curriculum. These explanations are covered in the SPSCB for the curriculum (Appendix C).

3.5.1.c Analysis of the curriculum

All of the parts in the curriculum were subjected to content analysis; (1) Basics of the Physics Curriculum, 17 pages; (2) Learning Areas of the Physics Curriculum, 11 pages; (3) Expectations from Textbook Writers and Physics Teachers, 3 pages; (4) Publications, 1 page; (5) Changes in the Physics Curriculum, 2 pages; (6) Content Organization of 9th Grade Physics Curriculum, 60 pages. Two parts in the curriculum were coded more relative to other parts; first sub-part of second part; the objectives of skills in the learning areas of the curriculum and the last part; Content Organization of 9th Grade Physics Curriculum. The objectives of skills in the learning areas of the curriculum have four sub-titles as (a) Problem Solving Skills; (b) Physics-Technology-Society-Environment; (c) Computational and Communicational Skills; (d) Attitudes and Values.

One of the characteristics of the curriculum is that each objective has also skill dimension listed and abbreviated in the second part of the curriculum. For example, the first objective of the first concept; Nature of Physics, is “1.1 investigates the question what is physics”. At the end of the statement some abbreviation is written in brackets like PTSE-1a, b, c, d; BIB-

1.a-d. These abbreviations referring to the skill objectives mentioned in the second part of the curriculum mean that these skills should be also taken into consideration in teaching. For instance, in the previous objective teacher should read the objectives numbered as PTSE1a, PTSE1b, PTSE1c, PTSE1d, BIB1a, BIB1b, BIB1c, and BIB1d and feed the main objective with these skill objectives while planning the lesson.

Due to this characteristic of the curriculum, each objective of the concepts was first coded regarding to itself. Then they were coded according to each objective of skills given in the brackets. For example, the objective "2.1 explain the importance of observing and experimenting in physics" was first coded as OKD3: "mentions the importance of observing in science" and EKD3: "mentions the importance of experimenting in science". However, this coding was not enough since the objective in the bracket (PTSE1b) addresses another code which was DSR2: "makes assumptions about the generalizability of the results obtained through scientific method". In brief, the objective 2.1 was coded as OKD3, EKD3, and DSR2.

Another characteristic of the curriculum is that it has explanation for almost all objectives. These explanations may be in six different way; in-physics association, Nobel Physics Reward, associating with other courses, misconception, warning, limitations. These explanations were also coded regarding science process skills. In the previous situation it is the objective coded according to skills objectives given in brackets, whereas this time it is the explanation coded. For instance, the explanation"[!] 1.2 informs students the reasons behind the connection way of circuit elements such as ammeter, voltmeter, and rheostat while students are setting up the circuit for discovering Ohm's Law" was coded as SKP2: "informed about how to measure any physical quantity". This explanation is a warning for teacher while planning the lesson for the objective "1.2 discovers the relation between current flowing through a conductor and potential difference between the conductor's two ends" in the Chapter of Electricity and Magnetism. Only the explanation was coded as SKP2, not the objective itself.

The 9th grade physics curriculum was read many times with the intention of getting used to the material to be coded. After getting used to material, the curriculum was coded according to the SPSCB with the qualitative data analysis software program; NVIVO 10. The coding process was due to the sequence of the curriculum. Thus, objectives for skills were coded before coding the objectives of content. It was also inevitable because of the mentioned rule above. The first coding process started at end of February, 2013 after the first analysis of the textbook. The findings of first coding process of curriculum and textbook are given in Appendix N and O, respectively by tables representing the frequencies of each code. The researcher decided to code the textbook again after the curriculum was coded in order to check and revise the coded and not coded units of analysis. Therefore, after textbook's second analysis, the curriculum was re-coded in April 2013. The tables representing frequency of each code organized through the second coding process are given in Appendix P and R for the curriculum and textbook, respectively. The results at Chapter 4 are based on and drawn from the second coding process of the curriculum.

3.5.2 Data analysis of the textbook

Content analysis was conducted to 9th grade physics textbook in this study. In this section, obtaining the textbook, determining unit of analysis and analysis procedure are explained.

3.5.2.a Obtaining the document

The hardcopy of 9th grade physics textbook was scanned and saved page by page and uploaded to NVIVO by grouping chapter by chapter. It was possible to upload the textbook in one document, but the researcher preferred to upload textbook page by page and group pages into chapters of the textbook. Thus, it was easy to follow codes during the checking and revising processes. Moreover, uploading document page by page does not force the software, supplying researcher to work on it for a longer time than working with one large document.

3.5.2.b Determining the unit of analysis

The unit of analysis for content analysis of 9th grade physics textbook was similar to the units defined for the curriculum; paragraph, sentence(s), questions, each step of activities, tables asking students to fill, figures and photograph with explanations, etc. The context unit was defined according to objectives of contents in the curriculum. The beginning and end points of context units for the textbook were written on the codebook with respect to objectives. The parts of the textbook were also mentioned in the code book; however they are not either unit of analysis or context units. Detailed description for unit of analysis is explained in SPSCB which is given in Appendix A.

3.5.2.c Analysis of textbook

Before the analysis began, the codebook had been read in details for dominating the codes and dimensions of the science process skills. In addition, the textbook was also read many times with the purpose of getting familiar with the material. After familiarization, the textbook was coded according to the SPSCB with the qualitative data analysis software program; NVIVO 10.

The textbook was started to be coded in September, 2012 as one document. Because of problems with the software and difficulty in following the codes in one document, it was decided to upload the document page by page. The coding process of textbook with page by page ended in December, 2012. After analysis of the curriculum, the researcher needed to check the analysis of textbook due to her experience. Finally, the textbook was coded for the second time in February, 2013.

3.5.3 Data analysis of physics lessons

The lessons of three physics teachers, who claim that they follow the 9th grade physics curriculum and take into consideration in the skill objectives, were observed. Three physics teachers were decided after observing lessons of 10 physics teachers during two and/or three weeks. The details about the date, time, and duration of the observation for each three physics teachers' lesson were given in Table 3.2.

The physics lessons were recorded by a camera. The videos were watched twice or more when needed, and coded accordingly SPSCB. Only the coded parts were transcribed because of huge amount of data. It would also be difficult to upload the video records to the software. The researcher preferred to code the video records firstly and then transcribed the coded part. However, not only the coded sentences or learning setting was transcribed, but the session of coded minutes or seconds were also transcribed in order not to miss data.

Analyses of the physics lessons were started after the 9th grade physics curriculum and the 9th grade physics textbook were analyzed. When the observation of all lessons finished, the researcher began to analyze the videos. The coding process took from middle of April, 2013 till end of May, 2013. After all videos were coded, the researcher shared the results with the teachers for validating them. Teachers were interviewed and asked whether the results are meaningful to them.

3.6 Reliability and Validity of Science Process Skills Code Book

In this section, the reliability and validity issues of SPSCB are presented. The procedure for calculating Krippendorff's α for intra-coder and inter-rater reliability is explained. The steps for constructing the validity of SPSCB are expressed in the second part of this section.

3.6.1 Reliability of science process skills code book

Reliability is tremendously essential to content analysis. High reliability indicates the technique or the procedure of the content analysis can be trusted. Moreover, it assures that the results can be reproduced. What makes a content analysis to be trusted is the coding; it must be reliable (Chiappetta, et al., 2006; Krippendorff, 2004; Neuendorf, 2002). Two types of reliability were used in this content analysis. The first one is intra-coder reliability which shows how consistent the analyzer with him or herself. It is also named as stability (Althide, 1996; Krippendorff, 2004; Miles & Huberman, 1994). In order to establish intra-coder reliability the same text was reanalyzed after a certain amount of time. The time between two analyses should be enough to ensure that the analyzer is not remembering how the text was coded at the first time. The 9th grade physics textbook analyzed during the period from the middle of December 2012 to end of January 2013 including the pilot coding process. After two months one of the chapters in the textbook, randomly selected, was recoded. The codes were compared, and α agreement for coding, Krippendorff's α was used in order to calculate the intra-coder reliability. According to comparison of codes done by the researcher at different times, Krippendorff's α was calculated as 0.82. The detail about calculation of α is mentioned in the following paragraph because both the intra-coder and inter-coder reliability coefficient was calculated in the same way.

The second type of reliability was inter-rater reliability which is described as reproducibility by Krippendorff (2004). Reproducibility is reached when two or more coders working independently, under varying conditions, generate the same results by analyzing the same text (p.215). To establish inter-rater reliability, one coder who is an expert in content analysis was trained in how to use the SPSCB. The code book was introduced to the coder by the researcher during two hours. After two weeks, the coder read the code book by his own; another discussion session was organized to discuss the questions of him about coding process. The codebook and the 9th grade physics textbook were given to the coder after he told that he understood the procedures. The coder was a PhD student studying content analysis in his research. The coder independently analyzed and coded the “Energy” chapter in the 9th grade physics textbook. The reliability coefficient was calculated according to Krippendorff’s α, because it is the most general agreement measure with two observers (Krippendorff, 2004). The Krippendorff’s α was calculated for two observers and many nominal categories. Firstly a table was prepared which shows all codes of two observers for each unit of analysis. Then it was transformed to a matrix of observed coincidences. According to the matrix, the agreement coefficient was computed as 1- $[D_o/D_e]$ (p. 228), and found 0.76 for the “Energy” chapter. It was not enough for the study, then coders came together to compare and analyze each unit of analysis coded differently. After discussing about the codes another coding process was started and another chapter of the textbook was re-coded. The chapter of “Electricity and Magnetism” was coded by the researcher and the coder. The Krippendorff’s α for inter-rater reliability was calculated as 0.83.

3.6.2 Validity science process skills code book

Another important issue for the quality of content analysis is validity or trustworthiness of the results. The quality of a content analysis is related to testing and increasing the trustworthiness of the research. When it is possible to increase the trustworthiness of the research, it leads to the acceptance and verification of the results. A procedure or method is regarded as valid if it “measures what is supposed to measure and performs the functions that it purports to perform” (Pattob, 2002, p. 53). Neuendorf (2002) defines validity as the extent to which a measuring procedure represented the intended, and only the intended, concept.

A content analysis is valid when there has been a meaningful relationship between the examining texts and the conceptual framework (Chiappetta et al., 2006). Chiappetta et al. (2006) suggested a list of areas in which validity is concerned with for content analysis research:

1. The accuracy of the selected sample (e.g., words, paragraphs, pages) represent the sample is analyzed,
2. The extent to which the categories of an analysis of texts correspond to the meanings these text have within the chosen conceptual framework, and
3. The accuracy of the adopted analytical constructs (i.e. categories) stand for the established uses and meaning of the text in the chosen context.

For establishing the validity mentioned in the first step, the sample accurately represented the whole sample in this content analysis. Because, the 9th grade physics curriculum and the

9th grade textbook were analyzed entirely. For the physics lessons, best teachers were selected to be observed.

For the second step, the codebook constructed by literature review on science process skills was examined by the experts. The experts assessed the accuracy of representation the meaning in the text and the accuracy of how to recognize science process skills in a text. The first version of the codebook was revised after the feedback was given by the experts. The pilot study for analysis of the textbook was helpful for further refinement of the codebook.

The final step, establishing validity is to use analytical constructs, or categories, that properly denoted the established meanings in the chosen context. The validity of the categories was directly related to the chosen conceptual framework and also to the conclusions drawn from the content analysis. In this study, the conceptual framework came from the literature about content analyses. The categories in codebook were also grounded from science process skills literature.

3.7 Ethical Issues

For the ethical issues, the most important point is to neither physically nor psychologically harm anyone during the research (Fraenkel & Wallen, 1996). In this study ethical issues emerged during the data collection process for the third research question. That is observation of 9th grade physics lessons. There are three main ethical issues taken into account during the research:

3.7.1 Protecting participants from harm

Since the data collection includes only observation of the physics lessons, there was no possible harm for anyone participated in this study.

3.7.2 Confidentiality of research data

Confidentiality of the data was ensured, and the participating students, teachers, and schools were assured any personal information would be protected in publications based on the research. Personal identifiable information was not asked to any student during the research. Background information of teachers was asked and teachers were guaranteed about the confidentiality of any information gathered from them. Moreover, the participants were told that participation could be withdrawn at any time.

3.7.3 Deception of subjects

The purpose of the research and the details about data collection process were explained to the principals, teachers, and students in each school. There was no problem to inform participants about the research. Thus, deception was not needed and involved in this study. In addition, permission to make observations in the high schools was taken from Rectorship of METU, the Graduate School of Natural and Applied Sciences, the Ethical Committee, and the Ministry of National Education (Appendix S). Also consent forms (Appendix T) for both students and parents were prepared; students and parents were asked them to read and to sign the consent form before accepting to be participant in the study.

3.8 The Profile of the Researcher

As Creswell (2003) mentions qualitative research in which the researcher has endured a focused relationship with the participants, is interpretive in nature. Clearly in this study, the researcher interacts between the 9th grade curriculum, the 9th grade textbook, and the teachers and the students in the 9th grade physics lessons.

There is always a tendency in both qualitative and quantitative researches to easily overlook prior assumptions, knowledge, or positions the researcher brought into their studies (Roman, 1992). Such “missing research” phenomenon neglects the fact that the process of selection and interpretation, which the researcher described and explained, resulted in only a limited or partial framework of understanding their works.

First, the researcher was non-participant observer. She did not manipulate students and the teachers about the teaching activities. Multiple observations continued about nine weeks in each of the settings, thus the study was a long term study. Lastly, focus of observations was on single element, on the teaching of science process skills.

3.9 Limitations of the Study

This study focuses on science process skills in the 9th grade physics textbook, the 9th grade physics textbook and the 9th grade physics lessons in Turkey. Thus, the conclusion can be generalized with regard to the themes generated in this study and these cases under investigation.

All categories within the analytic framework were generalized based on the literature review proposed contributions to science process skills. There could be additional categories depending on the framework generated for this study. The results of this study were limited with the themes generated with respect to literature on science process skills. Beside the categories, coding for the science process skills is another limitation. The validity of the study relies on two coders’ understanding of the science process skills and its categories.

Content analysis is limited by the availability of documents. In this case study, the results were valid only the 9th grade physics curriculum, the 9th grade physics textbook, and the 9th grade physics lessons of those selected teachers participated in this study. The results cannot be generalized to all physics curriculum, textbooks or any other physics textbook or teachers. The results are limited specifically to the physic curriculum, the physics textbook and the physics teachers investigated in this study.

This study is limited with the case in the third research question; the 9th grade physics lessons in Ankara, Turkey. Although the physics lessons were observed and analyzed, it does not provide a systematic understanding of how all physics teachers use the curriculum and the textbook content to teach the science process skills. The results of third research question were limited with the teachers participated in this study. Thus we can interpret the results as in the case of teachers' lessons who claim that she/he implement the 9^{th} grade physics curriculum focusing also objectives of skills. In addition to the limitation for the third question, the results were also limited to the energy chapter.

3.10 Procedure

3.10.1 Researched databases and keywords

The databases at METU and UMD were examined. The databases accessed are listed below; Academic Search Complete, American Institute of Physics (AIP), American Physical Society (APS), Dissertations and Theses, Education Research Complete, ERIC, Science Direct, SocINDEX with Full Text and Taylor & Francis Online Journals.

Key words used for this study are; science process skills, inquiry skills, observing, measuring, classifying, inferring, communicating, predicting, hypothesizing, defining variables, controlling variables, gathering data, interpreting data, experimenting, designing experiment, modeling, content analysis, codebook, science curriculum, reform in science education, reform in physics education, textbook analysis, physics curriculum, evaluation of textbook, science textbook, physics textbook, physics instruction, physics teachers, science educators, etc. These key words not only used separately but also binary and triple, for example, “science process skills” + “science curriculum” and “inferring” + “textbook analysis” + “science education”.

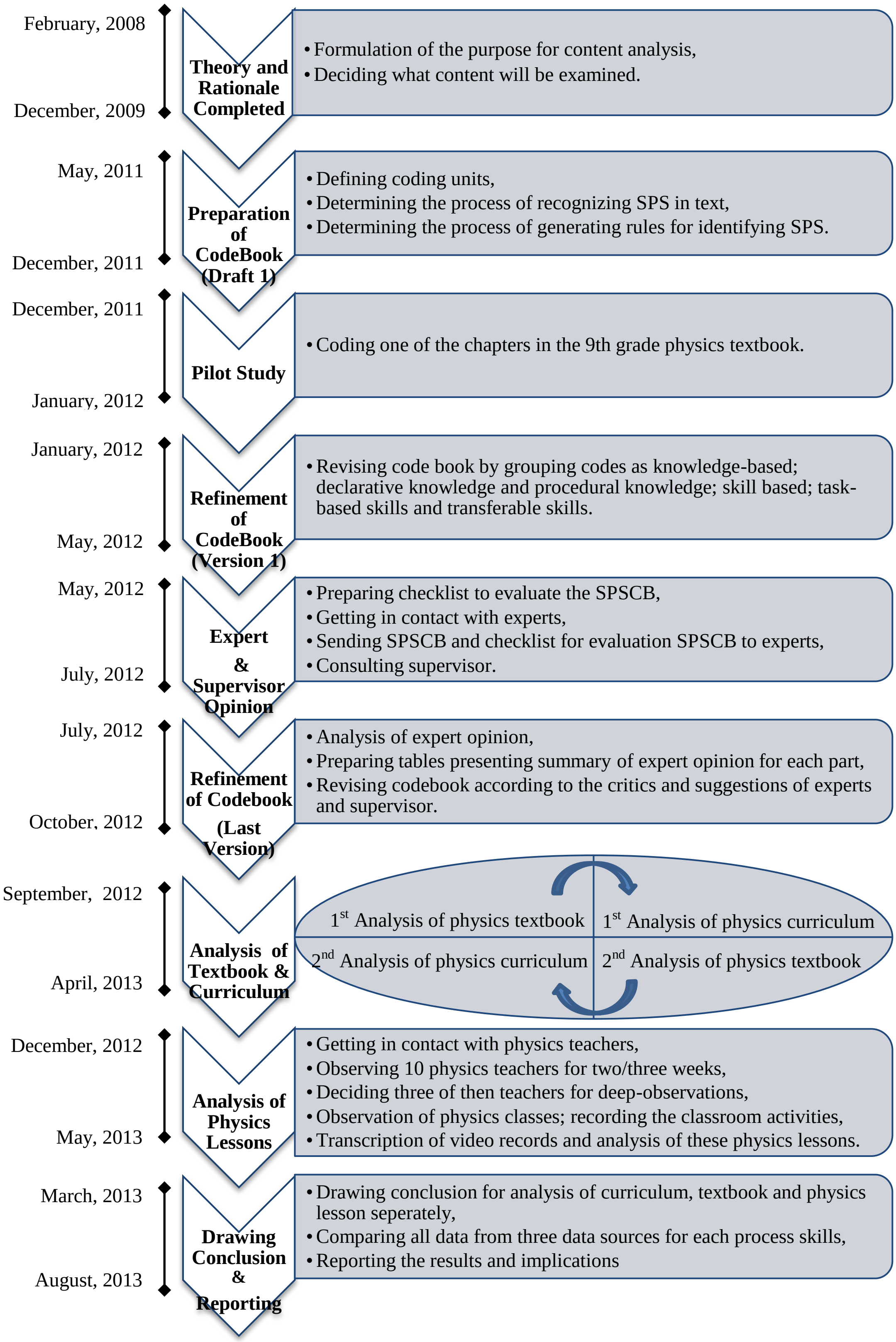


Figure 3.3 Procedure of content analysis

CHAPTER 4

RESULTS

This chapter is composed of four sections accordingly to research problems. In the first section, findings relate to the first research problem, what extent are science process skills included in the Turkish 9th grade physics curriculum, are presented. The findings in the first section are organized into three segments. These segments present the inclusion of SPS in skill objectives, content objectives, and combination of all parts of the curriculum, respectively. The second section responds to research problem two: What extent is science process skills included in the content of the 9th grade physics textbook published by Ministry of National Education. In the third section, the findings for the third research problem, what extent are science process skills included in the 9th grade physics lessons in the energy chapter, are presented. Finally, the last research problem, what extent is 9th grade physics curriculum, textbook and lessons consistent to each other in terms of science process skills, is addressed in the fourth section of this chapter.

4.1 Representation of Science Process Skills in the 9th Grade Physics Curriculum

In this section, the findings of content analysis of 9th grade physics curriculum with respect to SPS are presented. Brief descriptions about aims and vision of the curriculum are given in the beginning and then sequence of sub-section is explained.

The 9th grade physics curriculum has been developed to provide students with the basic physics concepts that they will need to cope with in real life problems. It aims to prepare the students to solve real life problems using scientific methods, analyze the interactions between Physics-Technology-Society and Environment, develop positive attitudes towards himself/herself and society. In addition, one of the purposes of the curriculum is to develop students' information literacy skills such as using computer and internet in an effective way, and being objective when expressing personal thoughts (TTKB, 2011).

Vision of the curriculum is not only to teach physics but also to develop students' skills. The curriculum intends to teach physics concepts by the skills which are composed of four main titles (1) Problem Solving Skills (PSS), (2) Physics-Technology-Society-Environment (PTSE), (3) Information and Communication Skills (ICS), (4) Attitudes and Values (AV). It aims to develop these skills by using the physics contents. The physics concepts in 9th grade are given in six chapters namely (1) Nature of Physics, (2) Properties of Matter, (3) Force and Motion, (4) Energy, (5) Electricity and Magnetism and (6) Waves. Therefore, the curriculum states two types of objectives; skill objectives and content objectives. In brief, the purpose of the curriculum is to teach physics by using the skills and develop these skills by using physics content (TTKB, 2011).

In data analysis of the curriculum, the skill objectives and content objectives are analyzed separately and then they are combined according to the pairings given in the curriculum. Beside the objectives, the parts named as “aim of the chapters”, “daily life context”, “scientific concepts”, “mathematical equations and units” are analyzed. In this section, the findings of each step are given, respectively. Firstly, the results of skill objectives’ analysis in the four areas are presented. Then, the findings of content objectives’ analysis in six chapters are given. Lastly, the final results of 9th grade curriculum which are the combination of results of skill and content objectives and the parts mentioned above are represented.

4.1.1 Representation of science process skills in the skill objectives

In the curriculum, the skills of science process, creative thinking, critical thinking, analytical and spatial thinking, and higher order thinking are grouped under the heading of PSS as the first part of skill objectives (TTKB, 2011). There are 22 skill objectives of problem solving skills given in three parts; “defining the problem and planning the solution”, “collecting data and making experiment” and “interpreting the data”. The result of document analysis showed that only 1 objective does not include any SPS. Other 21 PSS objectives out of 22 include science process skills of at least of the skills as collecting-interpreting data, experimenting, defining-controlling variables, hypothesizing, modeling and measuring.

In the second part of skills, PTSE, there are three parts having 40 objectives in total. The 37 of 40 objectives take account of at least one SPS of collecting-interpreting data, scientifically communicating, experimenting, inferring, defining-controlling variables, hypothesizing and observing. However, the skills of modeling, measuring, predicting and classifying are not involved in this part of the curriculum.

There are 22 objectives defined for the skill of ICS which is the third part of skill objectives. Depending on document analysis 20 of these 22 ICS objectives include mostly the science process skills of collecting-interpreting data, and scientifically communicating. Only one objective includes the skill of modeling. Other skills except collecting-interpreting data, communicating scientifically and modeling are not taken into consideration in the objectives of Information and Communication Technology part.

In the fourth and the last part of skill objectives there are 28 objectives grouped under the heading of AV. 14 of these 28 AV objectives are corresponding to science process skills of collecting-interpreting data, scientifically communicating and experimenting.

As the result of content analysis of these skill objectives, science process skills frequency distributions are given in Table 4.1. Science process skills are given in the first column; the names of skill area in abbreviation are placed in the first row. The numbers written under the abbreviations for the area of skills are the total number of objectives in each skill. The numbers written alongside each science process skill indicates number of objectives including the corresponding process skill. The objectives which do not include any science process skills are given as “Not SPS” in the table. There are some objectives referring more than one science process skills. For example, the objective in PTSE “makes a technological design and explains the scientific knowledge used in this process” represents both experimenting and scientifically communicating. Since this objective has two verbs, it implies two different science process skills. There are two objectives in both PTSE and ICS including two different SPS. That is why the sum of the numbers of “SPS Total” and “Not SPS” does not equal to the total number of objective skill in PTSE and ICS. Moreover, having objectives which involve more than one SPS causes the sum of percentage of skills and “Not SPS” becomes more than a hundred. The sum of percentage of all items equals to 103.5 meaning that 3.5 percent of the skill objective involve more than one SPS.

Table 4.1 Frequency distribution of science process skills for skill objectives

	PSS 22	PTSE 40	ICS 22	AV 28	# TOTAL 112	% in objectives (n=112)
Collecting & Interpreting Data	9	27	11	8	55	49.1
Communicating scientifically		3	10	3	16	14.3
Experimenting	3	2		3	8	7.1
Defining & Controlling Variables	3	1			4	3.6
Hypothesizing	2	1			3	2.7
Modeling	2		1		3	2.7
Measuring	2				2	1.8
Inferring		2			2	1.8
Observing		1			1	0.9
# of SPS Total	21	37	22	14	94	83.9
% in objectives (n=112)	18.8	33.0	19.6	12.5	83.9	
# of Not SPS	1	5	2	14	22	19.6

(PSS: Problem Solving Skills; PTSE: Physics-Technology-Society-Environment; ICS: Informatics and Communication Skills; AV: Attitudes and Values)

Table 4.1 shows that, there are 112 defined objectives for the skills in the physics curriculum. According to content analysis, 94 of these objectives refer to science process skills which mean 83.9 percent of the skill objectives. Collecting-interpreting data, communicating scientifically and experimenting belong to skills which highly take place in these objectives. Defining-controlling variables, hypothesizing, modeling, measuring, inferring and observing are rarely mentioned in the skill objectives of the curriculum. These rarely mentioned skills have the percentage of 13.5 altogether which is smaller than quarter of skill objectives. Additionally, the skills of predicting and classifying do not take place in the table, because they are not cited in the skill objectives in the physics curriculum. Moreover, according to Table 4.1, 19.6 percent of the skill objectives do not contain any science process skills.

According to Table 4.1, collecting-interpreting data is involved in 9 PSS, 27 PTSE, 11 ICS and 8 AV objectives. The total number of objectives involving the skill of collecting-interpreting data is 55 out of 112. In order to calculate the percentage of involvement of this skill among the total objectives 55, is divided by 112 and multiplied with 100, and after this calculation, the percentage is calculated as 49.1.

The maximum emphasized skill is collecting-interpreting data with 49.1 percentage indicating nearly the half of total skill objectives. PTSE has the maximum proportion (.68) for this skill; it is calculated as the division of the objectives coded as collecting-interpreting data (27) to the total objectives in PTSE (40). The skill objectives in PTSE emphasize the relation between physics, technology, society and environment. Students are expected to collect mostly qualitative data about physics as a branch of science and analyze nature of physics due to collected data. The objectives in PTSE expect students to realize the relation between physics and technology, physics and society, physics and environment. For example, the PTSE objective "investigate interaction between physics and technology" (TTKB, 2011, p.25) expects students to collect information about the physics, technology and interaction between physics and technology. Here are some PTSE skill objectives mentioning the skill of collecting-interpreting data in the curriculum (TTKB, 2011, p. 24-26);

- Defines physics and comprehends that physics helps understanding phenomena in the universe as a branch of science (PTSE1a).
- Realizes that the physics knowledge is developing rapidly (PTSE1c).
- Investigates the relation between physics and philosophy (PTSE1i),
- Comprehends the importance of relation between physics and technology in solving daily life problems (PTSE2d).
- Explains how person, society and environment affect physics and technology (PTSE3a).
- Investigates the relation between application of physics and ethical issues"(PTSE3f).
- Be acquainted with the importance and requirements of financial support for physics and technology projects (PTSE3i).
- Explains the contribution of our country to physics and technology (PTSE3p).

The skill of collecting-interpreting data is mentioned highly in the ICS objectives; 20.0 percent of objectives (n=55) involving these skills belong to ICS. The objectives referring to the skill of collecting-interpreting data are, for example "Verifies whether the source of information is valid and reliable" (ICS1b), "Investigates, attain, and select the information in relation to determined aim" (ICS1d), "Synthesizes the data and attain new information" (ICS2a) (TTKB, 2011, p. 27). Actually, the ICS objectives referring to these skills are emphasizing collecting data by using computer skills in general since the aim of ICS part is develop students' informatics, communication and computer skills.

Similar to PTSE and ICS, PSS has the maximum frequency for the skill of collecting-interpreting data; 40.9 percent of PSS objectives (n=22) refer to these skills. In addition, 16.4 percent of objectives (n=55) mentioning these skills are from PSS. Here are some example PSS objectives pointing out the skill of collecting-interpreting data in the curriculum (TTKB, 2011, p. 22, 23);

- Collects information from various sources to begin research by using pre-knowledge and experiences (PSS1b).
- Distinguishes scientific knowledge from personal thoughts and values" (PSS1c)
- Records the data in a systematic way with the units which are gathered from observation and measurement (PSS2f)
- Analyzes data obtained by experiment and observation by using tables, graphs, statistics or mathematical processes (PSS3a)
- Takes the limitations of the research into consideration while interpreting the result of the research (PSS3h)
- Makes a relation between the results of the research with others by comparing (PSS3i).

Collecting-interpreting data are also the highly emphasized skills among the AV objectives; 28.6 percent of AV objectives (n= 28) refer to these skills. The aims of AV part are to develop students' self-control, organization, study skills with scientific attitudes and values. Here are some examples for the objectives mentioning the skill of collecting-interpreting data in the curriculum (TTKB, 2011, p. 29, 30);

- Makes decisions according to evidences (AV1c).
- Evaluates his/her or others' work objectively and critically (AV1d).
- Knows the actual limitations of physics and technology and behave in accordance with these limitations (AV2b).
- Recognizes the importance of physics and technology for the development of our country and feel him/her responsible for the development of them (AV2f).
- Be willing to learn as a result of realizing the importance of lifelong learning (AV3a).
- Realizes the need of continuous improvement of his/her knowledge as a result of non-stop development of scientific knowledge (AV3c).

To sum up the result for the skill of collecting-interpreting data, they are the most highlighted skills in the skill objectives. PTSE, ICS and AV objectives are highly involve the skills of collecting qualitative data about physics, nature of physics. However, the PSS objectives are different from others in means of implying the process of problem solving.

Beside collecting-interpreting data, intensively covered process skills in the curriculum are communicating scientifically and experimenting. Total percentage (70.5) of above mentioned three science process skills is dominating the skill objectives. Communicating scientifically is emphasized mostly in the ICS objectives (62.5 %, n=16), frequently in the

PTSE and AV objectives. On the other hand, there is no PSS objective that involves the skill of scientific communication. The scientific communication skill takes place in the ICS, PTSE and AV objectives (TTKB, 2011, p.25-29);

- Prepares appropriate presentations for the determined aim (ICS3a).
- Uses proper terminology in the any type of communication (verbal, written visual, etc.) about physics (ICS4c).
- Improves necessary internet skills to obtain, develop and share information about physics (ICS5e).
- Makes a technological design and explains the scientific knowledge used in this process (PTSE2.f).
- Takes part in the discussions based on physics and technology that can affect the future of person, society and environment (PTSE3d).
- Explains importance of sharing the scientific or technological results by using proper communication medium (conferences, meetings, seminars, internet, television, radio, etc.) (PTSE3m).
- Listens and values others' opinions (AV1i).
- Values the work of scientists (AV1j).
- Follows and appreciates the development in physics (AV2a).

Skill of experimenting is the third involved one in the skill objectives of the curriculum that has percentage of 7.1. It is emphasized in both PSS and AV objectives (37.5 %; n=8) and also in PTSE objectives (25.0 %; n=8). Document analysis shows that no ICS objective refers to the skill of experimenting in the curriculum. Here are some example skill objectives which include experimenting (TTKB, 2011, p. 22-30);

- Recognizes and uses safely the appropriate experiment tools and materials (PSS2a),
- Designs an experimental setup in order to test a hypothesis (PSS2c),
- Makes a technological design and explains the scientific knowledge used in this process (PTSE2f),
- Knows basic principles to use experiment tools and materials safely (PTSE3r),
- Applies physics when necessary in order to make decisions about daily life problems (AV2c),
- Insists on making new trials to achieve the goal (AV3d).

Defining-controlling variables, hypothesizing, modeling, measuring, inferring, and observing are the science process skills which are involved but not given enough emphasis in the skill objectives. The percentages of these skills among all skill objectives are smaller than 5.0 (n=112), even the total percentage of these six skills is 13.5. Only 15 out of 112 objectives cover these skills and 14 of them belong to PSS and PTSE. The objectives PSS directly point out the skill of defining-controlling variables such as;

- Defines the problem (PSS1a),

- Defines the dependent, independent and controlled variables in a problem or research (PSS1e),
- Investigates the effect of independent variable on the dependent variable while controlling the other variables while testing a hypothesis (PSS2d).

The skill of hypothesizing is also given in the PSS and PTSE objectives directly;

- Makes a testable hypothesis for a defined problem (PSS1d),
- Designs an appropriate solution for a defined problem (PSS1g),
- Propose solutions by using physics and technology for corresponding social problems while taking the needs of person, society and environment into consideration for a better life (PTSE3k).

Modeling, on the other hand, is included in the skill objectives not directly but in terms of mathematical equations. For example the objectives pointing out the skill of modeling are; "Expresses the findings obtained as a result of data analysis in models like mathematical equations" (PSS3c); "Uses the proper mathematical equations when necessary in order to solve problems" (PSS3g) and "Prepares simple simulation and animations in order to make abstract concepts concrete, simulate physical activities which are expensive, dangerous and difficult" (ICS5f) (TTKB, 2011, p. 22-30).

Measuring, inferring and observing are rarely mentioned in the skill objectives of the curriculum. The total percentage of these objectives indicating these three skills is 4.5. The skill of measuring is involved only in two PSS objectives as; "Determines the appropriate measuring tool in order to measure variables" (PSS1f) and "Makes a sufficient number of measurements carefully with appropriate tools in order to reduce the error rate in measurement" (PSS1e). Inferring is involved only two PTSE objectives as; "Realizes and gives examples that physics-science-technology itself is neither good nor bad, but decisions about the use of products and systems can lead to desired or undesired results" (PTSE1l) and "Gives examples that physics and technology in rare cases cannot find the solutions to the problems of the person, society and environment with current knowledge" (PTSE3l). Finally, the skill of observing in mentioned in only one PTSE objective which is "Observe how the physics and technology are used by society to make decisions about environmental problems" (PTSE3h) (TTKB, 2001, p. 22-30).

To sum up, there are 112 skill objectives defined by the curriculum and 94 of them are found to involve SPS. The most emphasized SPS in the skill objectives are collecting-interpreting data whereas the skills of classifying and predicting are not involved in any objective. Communicating scientifically and experimenting are occasionally mentioned while defining-controlling variables, hypothesizing, modeling, measuring, inferring and observing are rarely cited in the skill objectives. According to content analysis of skill objectives, there are 22 objectives which do not cover any SPS. In addition, most of these objectives belong to AV with 63.6 percentage, others belong to PTSE (22.7 %), ICS (9.1 %) and PSS (4.5 %).

4.1.2 Representation of science process skills in the content objectives

The objectives, as mentioned before in the physics curriculum are grouped in two categories as skill objectives and content objectives. Due to one of the characteristics of the curriculum, almost each content objective is supported by more than one skill objective. The curriculum states that the skill objectives given in brackets for each content objective should be taken into consideration together. The content objectives are grouped in 6 chapters as (1) Nature of Physics, (2) Properties of Matter, (3) Force and Motion, (4) Energy, (5) Electricity and Magnetism and (6) Waves.

As a result of the content objectives' analysis, the frequency distributions of science process skills are given in Table 4.2. The first row of Table 4.2 indicates the chapters of content proposed by the 9th grade physics curriculum. The numbers written in the second row demonstrate the total objective number offered by the corresponding chapter. In the eighth and ninth column the total number of objectives and their percentage for each science process skills are placed. For example, according to Table 4.2, the skill of classifying is mentioned in 13 out of 69 content objectives which mean 18.8 percent of all content objectives.

Table 4.2 Frequency distribution of SPS in the content objectives

	Chapters						# total	%
	NoP	PoM	FM	ENJ	EM	WV	Obj	in obj.
# of objectives	15	8	13	17	7	9	69	(n=69)
Collecting & Interpreting Data	3	1	5	8	0	0	17	24.6
Classifying	2	6	1	3	0	1	13	18.8
Experimenting	1	0	5	0	5	0	11	15.9
Modeling	2	1	2	0	1	1	7	10.1
Measuring	2	1	0	0	0	1	4	5.8
Observing	2	0	0	0	0	0	2	2.9
Defining & Controlling Variables	0	0	0	0	0	1	1	1.4
# of objectives including SPS	12	9	13	11	6	4	55	79.7
% in objectives (n=69)	17.4	13.0	18.8	15.9	8.7	5.8	79.7	79.7
# of Not SPS	3	0	2	6	1	5	17	24.6

(NoP; Nature of Physics, PoM; Properties of Matters, FM; Force and Matter, ENJ; Energy, EM; Electricity and Magnetism, WV; Waves.)

The results obtained from analysis of the content objectives indicate that the skill of collecting-interpreting data is the mostly involved science process skills. The percentage of involvement of these skills is 24.6 among the all content objectives (n=69) whereas it is 30.9 percent among the content objectives including SPS (n=55). According to Table 4.2 almost half of the objectives (47.0 %, n=17) containing the skill of collecting-interpreting data are from the energy chapter. For instance, the content objectives pointing out collecting-interpreting data are;

- Realizes that energy can be defined in different ways (Energy, 1.2).
- Realizes that physics investigate objects, phenomenon and events in the universe in different sub-branches (Nature of Physics, 1.2).
- Realizes that motion is a relative phenomenon (Force and Motion, 1.1).

The skills of classifying, experimenting and modeling are belong to science process skills which are mostly included in the content objectives. Classifying is mostly involved in the chapters of Properties of Matter (46.2 %, n=13) and Energy (23.1 %, n=13). Because classifying is not included in the skill objectives, it depends on the content in the curriculum. Examples for content objectives referring the skill of classifying are;

- Classifies the matters according to their phases (Properties of Matter, 1.2).
- Compares advantages and disadvantages of renewable and non-renewable energy sources (Energy, 3.1).
- Classifies the magnitudes in physics as scalar and vector (Nature of Physics, 2.6).
- Classifies the waves according to energy and the direction of vibration (Waves, 1.6).

Experimenting is emphasized mostly in the chapters of Force and Motion and Electricity and Magnetism with the same percentage (45.5 %, n=11) among the all chapters. The skill of experimenting is given more emphasis in the content objectives (15.9 %, n= 69), rather than the skill objectives (7.1%, n=112). This difference in percentages indicates content dependency of the experimenting skill like classifying in the physics curriculum. Examples for the content objectives implying the skill of experimenting are given below;

- Explains the role and importance of observing (qualitative and quantitative) and experimenting (Nature of Physics, 2.1).
- Discovers the dependent variables of friction force by experimenting (Force and Motion, 4.1).
- Shows the dependent factors of a conductor’s resistance with experiment (Electricity and Magnetism, 1.3).

Modeling is included in 12.7 percent of content objectives, which involves SPS and 10.1 percent of all content objectives. The frequency distributions of modeling for content objectives in chapters are close to each other, excluding the chapter of Energy in which no evidence is found. Since using mathematical equation properly is included in the skill of modeling, the objectives about calculation in which mathematical equations needed are coded as SPS, modeling. The objectives referring to the skill of modeling in the curriculum are;

- Explains with examples that, in the case of necessity, modeling and mathematics are used while describing physical events (Nature of Physics, 3.1).
- Calculates the density of solid and liquid matters by utilizing mass-volume graphics (Properties of Matter, 1.4).
- Calculates the displacement by using speed-time graphics for linear motions (Force and Motion, 1.5).
- Designs a simple electrical motor (Electricity and Magnetism, 2.3).
- Makes a model that avoids loss of life and properties caused by earthquake (Waves, 1.9).

Having a total percentage of 10.1 for measuring, observing, defining-controlling variables skills, it can be said that these skills are rarely mentioned in the content objectives. The content objectives including the skill of measuring are; “Measures some basic physical quantities by using proper measuring devices and units” (Nature of Physics, 2.3); “Measures the volume of solid and liquid matters” (Properties of Matter, 1.3) and “Explains wavelength and frequency with examples and indicates their units” (Waves, 1.2). The observation skill takes place in the content objectives as “Explains the role and importance of observing (qualitative and quantitative) and experimenting” (Nature of Physics, 2.1) and “Realizes by comparing that quantitative observations in physical phenomenon are more objective and confident than qualitative objectives” (Nature of Physics, 2.1). Finally, the skill of defining-controlling variables is placed in the objective “Determines the relationship between period and frequency” (Waves, 1.3). Beside these rarely mentioned science process skills, the skills of predicting, inferring, communicating scientifically and hypothesizing do not take place among the content objectives in the physics curriculum.

4.1.3 Representation of science process skills in the curriculum

Since the curriculum states to feed the content objectives in harmony with the skill objectives, there is a need for handling these objectives altogether for one more time. By doing so, it will be more comprehensible to bring up the involvement of science process skill in the physics curriculum. Therefore, the content objectives were analyzed by taking into account the corresponding skill objectives. Moreover, in the curriculum the content objectives have explanations consisting of warning, limitations, relations with other disciplines and misconceptions. These explanations were also analyzed and the results were combined with the findings of analysis of content and skill objectives. Eventually, the frequency distributions of SPS in three parts of objectives are attained as portrayed in Table 4.3.

Table 4.3 displays the frequency distribution of science process skills in content and skill objectives and explanations of content objectives per chapter. In the first row, six chapters are given in abbreviations. In the second row, the total numbers of objectives in chapters are given in the first line and the numbers of corresponding objectives from content and skill ones with explanations are given in the second main line. Since the content objectives are basics of the curriculum, they are written in the first line. In the second line the details are presented; the number of content objectives, skill objectives and explanations are given separately in main second line. C/S/E stands for the number of content objectives, skill objective, and explanation, respectively. For instance, there are 8 content objectives in the Chapter of Properties of Matter. The numbers in in the second line 8-55-12 mean that there are 8 content objectives and 55 skill objectives and 12 explanation items attached into these 8 content objectives.

In the following rows, the total frequency of SPS for each chapter is given with the detail; SPS frequency for each type of objective and explanation is given in brackets with the same manner. For example, the skill of collecting-interpreting data is included by three objectives in total. The numbers in bracket under 3, (1/3/0) points out that the skill of collecting-interpreting data is included by only 1 content objective, 3 skill objectives which were attached to the content objectives. The last number in bracket "0" indicates that these skills do not take place in any explanation of the content objective. When the content and skill objectives and explanations are coded by unique SPS, the total number of coding should be the sum of all. In the mentioned example, the total number is expected to be 4 as the sum of (1.3.0). However, the total number is 3; that means one SPS is common in content and skill objectives. As stated in the rules for analysis in the SPSCB, the repeated code for a unit of analysis should be counted as one (Appendix A). According to this rule, the total number can be equal but not be bigger than the sum of the numbers in a bracket.

In Table 4.3 the occurrence distributions of science process skills with the details are shown in the third row of the table. In the fourth row, the total SPS per chapters and their percentages with respect to both total number of objectives and sum of SPS are presented. In the first line of the last row, the total number for SPS in each chapter is given and the total number of SPS for content and skill objectives and explanations are placed in the second line in brackets. Due to the rule mentioned in the previous paragraph, the number in the first line can be equal or smaller than the sum of the numbers in the bracket. The third line displays percentages of total SPS in total objectives (n=69). Lastly, the fourth line shows the percentages of total SPS in the sum for all chapters (n=219). For example, the total SPS involved in the Properties of Matter chapter is 23. This value is the combination of SPS from content objectives (9), skill objectives (14) and explanations (6) which is presented as (9/14/6) in the table. In addition, 33.3 percent of 69 objectives involve SPS in the Properties of Matter chapter. When the percentage is calculated for 219 coded SPS, it makes more sense to state that the 10.5 percent of SPS are covered by the second chapter in the curriculum.

The total number of SPS of a specific skill is presented in the eighth column with details in brackets showing how many SPS come from content, skill objectives and explanation items. For instance, the skill of experimenting is coded for 29 times in 69 objectives. According to the numbers given in the bracket, 11 experimenting units belong to content objectives, 26 of them belong to skill objectives and 1 belongs to explanations. In the last column, the percentages for SPS in the objectives and total SPS are given. The ones in the first line of corresponding skill show the percentage in 69 objectives, the others in the second line which is given in bracket show the percentage in 219 SPS. For the skill of experimenting it means that 42.0 percent of 69 objectives and 13.2 percent of 219 SPS coded in the objectives involve this skill.

Table 4.3 Frequency distribution of SPS in the 9th grade physics curriculum objectives

	Chapters						# total	%
	NoP	PoM	FM	ENJ	EM	WV	obj	
Objectives	15	8	13	17	7	9	69	n=69
Content O.	15	8	13	17	7	9	69	(n=219)
Skill O.	41	55	169	127	61	56	509	
Explanation	16	12	12	20	14	18	92	
Cl. Int. D.	12	3	13	14	5	9	56	81.2
(C/S/E)	(3/11/0)	(1/3/0)	(5/12/0)	(8/14/0)	(0/5/0)	(0/9/0)	(17/54/0)	(25.6)
Sci. Com.	1	6	10	16	3	4	40	58.0
	(0/1/0)	(0/6/0)	(0/10/0)	(0/16/0)	(0/3/0)	(0/4/0)	(0/40/0)	(18.3)
Exp.	6	2	5	4	7	5	29	42.0
	(1/5/0)	(0/2/0)	(5/5/0)	(0/4/0)	(5/5/1)	(0/5/0)	(11/26/1)	(13.2)
Measr.	4	2	6	2	5	3	22	31.9
	(2/3/1)	(1/1/1)	(0/6/0)	(0/2/1)	(0/4/2)	(1/2/1)	(4/18/6)	(10.0)
Class.	2	8	1	3	1	5	20	29.0
	(2/0/0)	(6/0/5)	(1/0/1)	(3/0/1)	(0/0/1)	(1/0/5)	(13/0/13)	(9.1)
Hypt.	2	1	6	3	4	3	19	27.5
	(0/1/1)	(0/1/0)	(0/6/0)	(0/3/0)	(0/4/0)	(0/3/0)	(0/18/1)	(8.7)
Model.	2	1	3	0	5	3	14	20.3
	(2/2/0)	(1/1/0)	(2/3/0)	(0/0/0)	(1/4/0)	(1/2/0)	(7/12/0)	(6.4)
Df. Ct. V.	1	0	6	0	4	2	13	18.8
	(0/1/0)	(0/0/0)	(0/6/0)	(0/0/0)	(0/4/0)	(1/2/0)	(1/13/0)	(5.9)
Obsrv.	3	0	1	2	0	0	6	8.7
	(2/0/1)	(0/0/0)	(0/0/1)	(0/2/0)	(0/0/0)	(0/0/0)	(2/2/2)	(2.7)
# SPS	33	23	51	44	34	34	219	100.0
(C/S/E)	(12/24/3)	(9/14/6)	(13/48/2)	(11/41/2)	(6/29/4)	(4/27/6)	(55/183/23)	
% (n=69)	47.8	33.3	73.9	63.8	49.3	49.3	317.4	317.4
% (n=219)	15.1	10.5	23.3	20.1	15.5	15.5	100.0	100.0

(Chapters: NoP; Nature of Physics, PoM; Properties of Matters, FM; Force and Matter, ENJ; Energy, EM; Electricity and Magnetism, WV; Waves. Objectives: C: Content objectives, S: Skill Objectives, E: Explanations. Science Process Skills: Cl. Int. Dt.: Collecting-Interpreting Data, Sci. Com.: Scientific Communication. Exp.: Experimenting, Measr.: Measuring, Class.: Classifying, Hypt.: Hypothesizing, Model.: Modeling, Df. Ctr. V.: Defining-Controlling Variables, Obsrv.: Observing)

According to Table 4.3, there are two SPS which is involved in only skill objectives: communicating scientifically and hypothesizing. Communicating scientifically is the second skill for the frequency distribution of SPS in the skill objectives (Table 4.1) whereas it is not mentioned in the content objectives (Table 4.2). It can be concluded that the skill objectives of Communicating scientifically are connected with several content objectives in the curriculum. For example, the content objective from the chapter of Waves "1.1 Explain the concepts of vibration and wave with examples" is fed by the skill objectives ICS 1a, b, c, d, 2a, 4c, d in which the communicating skill is mentioned. The objectives of ICS4c; "Uses proper terminology in the any type of communications (verbal, written visual, etc.) about physics" and ICS4d; "Expresses the complex information in a clear and understandable way" point out the importance of using proper terminology and clarity in communicating. These 40 units coded as communicating scientifically belong to the skill objectives as it is shown in the table (0/40/0). As a result, the physics curriculum covers the skill of communicating scientifically in 40 objectives (58%).

Similar to the skills of collecting-interpreting data, hypothesizing is mentioned by only skill objectives except from one explanation. According to the Table 4.1, 2.7 percent of skill objectives include hypothesizing. When it is compared with the corresponding value in Table 4.3: 19 (0.18.1); it increased from 3 to 18. That means the skill objectives indicating hypothesizing repeated in many times in the content objectives. This skill is underlined by three skill objectives which are (1) PSS1d. "Makes a testable hypothesis for a defined problem", (2) PSS1g. "Designs an appropriate solution for a defined problem" and (3) PTSE3k. "Propose solutions by using physics and technology for corresponding social problems while taking the needs of person, society and environment into consideration for a better life". The most involved skill objective is PSS1g (12 out of 18) in the content objectives, next is PTSE3k (4 out of 18) and the last one is PSS1d (2 out of 18).

Opposite to the scientific communication and hypothesizing, the skill of classifying is not involved in the skill objectives whereas it is the second highly involved SPS in the content objectives. Due to the combination of skill objectives with the content objectives, classifying takes place in the result of combined analysis with 20 (13.0.13) corresponding objectives. It is highly involved in the Properties of Matter; the chapter itself covers the concept of classifying. According to Table 4.3, the skill of classifying is coded for 20 times in the 69 objectives. 40 percent of these objectives belong to the chapter of Properties of Matter, 25 percent belong to the chapter of Waves and 15 percent belong to the chapter of Energy.

Beside to the content objectives, some classifying units belong to the explanations. For instance, the content objective from the chapter of Waves "1.3 Determines the relationship between period and frequency" is not coded as the classifying unit. The skill objectives of PSS 1e, f, g, 2a, c, d, and f are attached to this content objective, however none of them includes the skill of classifying. The explanation of this content objective includes the classifying as stating that "Emphasize that every movement having frequency and wave length is not a wave, such as simple harmonic motion and pendulums". In the corresponding content objective, the concepts of frequency and period and their relationship are aimed to be learnt, in the explanation these properties of waves are underlined. Since these properties are common with some other motions like simple pendulum, in the explanation it is expressed not to generalize all motions which have frequency and period as wave. This information is about the classification of motions that is why the explanation is coded as SPS.

According to Table 4.3, there are nine SPS involved in the objectives as whole; the combination of content objectives with explanations and skill objectives of the curriculum. The skills of predicting and inferring are not included by these objectives. Looking back to Table 4.1 and Table 4.2, predicting do not take place in neither skill nor content objectives However, the skill of inferring takes place in the PTSE skill objectives. According to Table 4.3, inferring is not included in the curriculum. Thus, it is revealed that the PTSE objectives which refer to the skill of inferring are not attached to any content objective. Since they are not collaborated with content objectives, the skill of inferring is not emphasized in the curriculum in spite of being involved by two PTSE objectives. In brief, the physics curriculum does not cover the skills of predicting and inferring.

Table 4.3, in accordance with Table 4.1 and 4.2, shows that the skill of collecting-interpreting data (25.6 %, n=219) are the most emphasized ones in the curriculum. Similarly, they are the most involved skills in three chapters. 56 (out of 69) objectives include these skills which means the 81.2 percent of all objectives and 25.6 percent of all SPS coded in the objectives (n=219). As indicated by Table 4.3, the skills can be grouped in five regarding their SPS frequency levels in the curriculum. Table 4.4 shows distribution of SPS due to their frequency level in the 9th grade physics curriculum objectives.

Table 4.4 SPS accordingly their frequency level in the objectives

Frequency Level				
Generally (%≥25)	Periodically (24≥%≥11)	Occasionally (10≥%≥5)	Rarely (4≥%≥1)	Never (0)
Collecting-Interpreting Data	Scientific-Communicating Experimenting	Measuring Classifying Hypothesizing Modeling Defining-Controlling Variables	Observing	Predicting Inferring

According to Table 4.4, the skill of collecting-interpreting data are generally; communicating scientifically, experimenting, measuring are periodically; classifying, modeling, hypothesizing, defining-controlling variables are occasionally; observing is rarely; inferring and predicting are never emphasized in the combination of skill and content objectives with explanations.

Beside the objectives, in the analysis of curriculum other parts namely “aim of the chapters”, “daily life context”, “scientific concepts”, “mathematical equations and units” were also coded. For example, mathematical equations are aimed to be learnt in the curriculum. The students are expected to understand the relations among quantities by using pre-established mathematical models. Therefore, the parts of mathematical equations in the curriculum are coded for modeling. In addition, there is information about the units of physical quantities in the curriculum. These parts emphasize the importance of using proper units for quantities to be learnt. Thus, the parts including information about the units are coded for measuring. Figure 4.1 summarizes SPS' frequency levels:

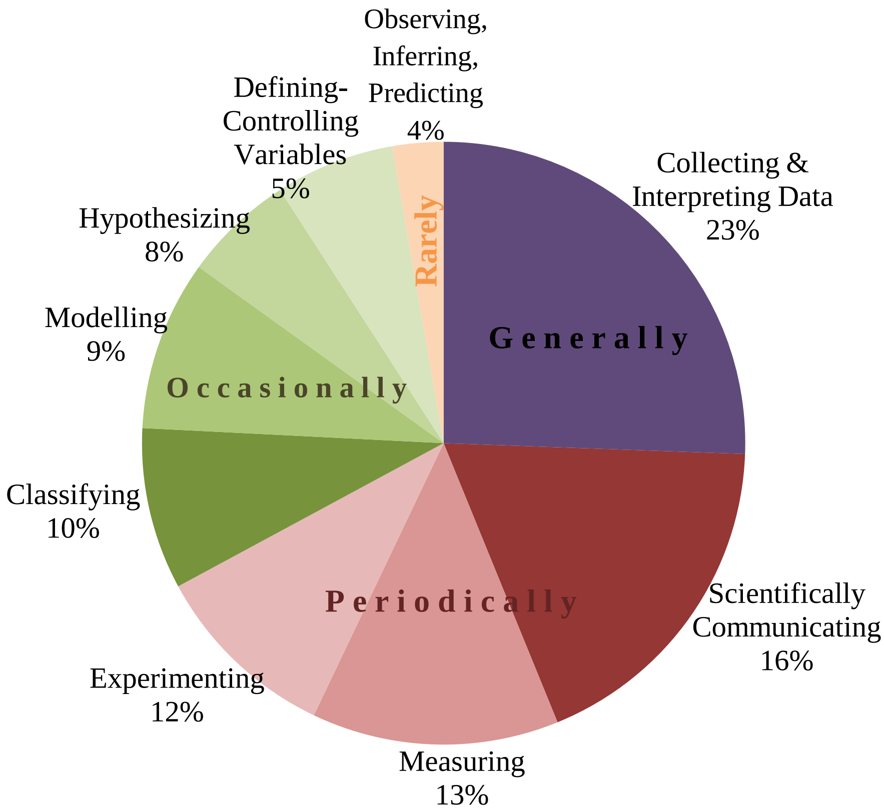


Figure 4.1 Frequency level of SPS (n=255) in the 9th grade physics curriculum

When the results of content analysis of objectives are combined with the other parts' findings, slight differences occurred in the ranking of the SPS. For instance, the skill of measuring which was the fourth one rose to third, while experimenting at the third line dropped to fourth in the last ranking. Similar to measuring, modeling also raised from the line seven to six by passing the skill of hypothesizing. Moreover, the skills of inferring and predicting were included in the last distribution.

In the content analysis, the researcher aimed to distinguish the involvement of SPS according to their domains; knowledge-based and skill-based. The mentioned frequencies are the total of knowledge-based and skill-based SPS. In Table 4.5, the frequency distributions of SPS for whole curriculum are given in two domains.

Table 4.5 Distribution of SPS in the knowledge and skill based domains

	Knowledge-Based (%)	Skill-Based (%)	Total	% (n=255)
Collecting & Interpreting Data	1 (1.7)	57 (98.3)	58	22.7
Communicating scientifically	1 (2.5)	39 (97.5)	40	15.7
Measuring	15 (45.5)	18 (54.5)	33	12.9
Experimenting	6 (18.8)	26 (81.3)	32	12.5
Classifying	1 (3.7)	26 (96.3)	27	10.6
Modeling	4 (18.2)	18 (81.8)	22	8.6
Hypothesizing	2 (10.0)	18 (90.0)	20	7.8
Defining & Controlling Variables	1 (7.7)	12 (92.3)	13	5.1
Observing	4 (50.0)	4 (50.0)	8	3.1
Inferring	1 (100.0)	0 (0.0)	1	0.4
Predicting	1 (100.0)	0 (0.0)	1	0.4
Total	38 (15%)	218 (85%)	255	100.0

According to Table 4.5, except the skills of measuring and observing almost all SPS are emphasized in the curriculum belong to skill-based domain. That means curriculum emphasizes developing the skills of students rather than informing them about these skills. Only the skills of measuring and observing have balance between the domains. In order to clarify the difference between the domains, the examples are given below. Knowledge-based domain is divided as declarative knowledge and procedural knowledge. They were explained in the Introduction under the heading of "1.3.1.a Domains in the code book" (p. 9). Here are examples of skills of measuring and observing from the curriculum for both declarative (DK) and procedural knowledge (PK). These examples are given from the curriculum, the explanations are written in brackets whether they are skill objective, content objective or an explanation for objective:

- kHz, MHz units and their conversions are given (Measuring,DK; Explanation for objective 1.2, Waves).
- Converts the unit of some basic physics quantities into its upper and lowers by defining them in SI (Measuring, DK; obj.2.4, Nature of Physics).
- Explains the importance of observing (quantitative and qualitative) and experimenting in physics (Observing, DK; PTSE 1b).
- It is emphasized that quantitative and qualitative observations are not opposing terms and they can be used together (Observing, DK; Explanation for objective 2.2, Nature of Physics).
- Students are informed about the reasons of connection styles of circuit elements such as ammeter, voltmeter and rheostat, while setting up circuits to explore Ohm law (Measuring, PK; Explanation for objective 1.2, Electricity and Magnetism),

- Use of solid (metal couples,…), liquid (with mercury, alcohol, …) and gas thermometers are specified (Measuring, PK; Explanation for objective 4.2, Energy).
- Volume of non-soluble solids in uniform shapes, excluding sand or similar, are calculated. Others are measured by the help of graduate. It is emphasized that the gases gets the form of the cup in which they are (Measuring,PK; Explanation for objective 1.2, Properties of Matter).
- Commonly used equaled arm balances explain the working principles of analog and digital bath scales (Measuring, PK; Explanation for objective 2.3, Properties of Matter).
- Stationary and non-stationary observer terms should be expressed so carefully, and it is emphasized that there is no absolute reference point in the universe (Observing, PK; Explanation for objective 1.1, Nature of Physics).

To sum up, Table 4.5 also presents the final frequencies of SPS as the result of content analysis of each part in the 9th grade physics curriculum. The content analysis of the curriculum shows that collecting-interpreting data are the most underlined skills. Communicating scientifically, measuring and experimenting are also given emphasis by the curriculum. However, modeling, hypothesizing, defining-controlling variables are rarely mentioned. There are also some science process skills which are almost never included in the curriculum; these are observing, inferring and predicting.

4.2 Representation of Science Process Skills in the 9th Grade Physics Textbook

Based on the second research problem of this study, the 9th grade physics curriculum was analyzed according to the SPSCB. In this section, firstly the procedure of data cleaning for repeated SPS in the textbook is explained; how intersections of codes in the same domain were determined and handled. Then the results of 9th grade physics textbook's content analysis are presented. The skills which are highly emphasized in the textbook are clarified with example excerpts in the second part. The textbook is in Turkish, the example excerpts given in this part are translated in English by the researcher. The second part also includes the distribution of SPS in the parts of the textbook and in the knowledge-based and skill-based domains. This section ends with a figure which shows the frequency levels of skills in the textbook.

4.2.1 Data cleaning for the analysis of 9th grade physics curriculum

According to the analysis rules, one coding unit should not be coded by the same SPS code. However, it is possible to code an excerpt in the textbook as the same SPS for many times. Because the codebook states different definitions for some of the skills in the same domain, the coding unit can include more than one code. For example, collecting-interpreting data has four different codes in the skill-based domain as DSTP, DSTM, DSR1 and DSR2. DSTP refers to collecting data, DSTM refers to organizing data, DSR1 refers to interpreting collected data and DSR2 refers to make generalizations according to the interpretations. They are related to each other and have a hierarchy among them; DSR2 includes other three codes, DSR1 includes first two codes and DSTM includes DSTP. In order to prevent coding an excerpt by the same code more than one time, the “Matrix Coding Query” was run by NVIVO. This matrix shows intersections among each code in the coding units. The results of the Matrix Coding Query are given in Appendix U. According to these results, the common units were re-analyzed and coded by the comprehensive one. For instance, when an excerpt is coded as DSTM and DSR1, it was revised and marked as DSR1. In this way the codes are prevented to be distended.

The textbook was uploaded to the NVIVO page by page; the numbers in the table of matrix (Appendix U) refers to the page numbers in which the corresponding codes are included. However, there can be more than one coding unit in a page. Because of this fact, there are some intersections of codes; nevertheless they are small in number. In addition, the codes from different domains as knowledge or skill based were not induced to one code since they are not belonging to same domain. Moreover, it is important for this study to distinguish the codes with respect to being knowledge-based or skill-based. Therefore, excerpts coded by different codes of same skill, but from different domains are coded for more than one SPS.

4.2.2 Representation of science process skills in the textbook

The 9th grade physics textbook contains of six chapters; they are “Nature of Physics”, “Energy”, “Properties of Matter”, “Force and Motion”, “Electricity and Magnetism” and “Waves”. The textbook consists of many parts; these are given in Table 4.6 with the explanations translated from the textbook:

Table 4.6 Parts in the 9th grade physics textbook

Name of Parts	Explanations in Textbook
Let's Investigate	Learned concepts are investigated, different sources are explored to find relationship with daily life and results are shared in class
Activity	Students are asked to discover intended information by themselves, utilizing supplied tools and devices
Do You Know This?	Principle and noteworthy information about learned subjects are supplied
Example	Develop students' ability of using information that they discovered
Project	Make students transfer information they discover into implementation in a system
Homework	Involves studies and activities of students outside the school in order to extend some objectives
Let's Discuss	Some laws or theories are discussed
Introduction of Chapters	Contains main subjects and objectives to be taught
Assessment & Evaluation	Learned knowledge is tested with different type of questions (true-false questions, open ended questions, fill in the blank type questions etc.) in both classical and new approaches
Problem Solving	Ask students to find solutions for problems that can be faced in daily life
Have You Ever Thought?	On behalf of better preparation for subjects, attractive questions according to main goals of the corresponding part are asked
Context of Chapter	Concepts in the parts and tools, devices and events from daily life are associated.
Attention	Describes precautions should be taken against possible dangers that be encountered during some activities and investigations
Let's Do More	That is the part which aims to make the learned concepts become permanent.

Beside these defined parts in the textbook, the researcher added a few parts during the content analysis. These are chart, table, figure, box, and paragraph in the textbook. Box refers to text in the book given in a box. Cases from daily life, history in physics or passing events are given in these boxes. In content analysis of the textbook, these parts are taken into consideration to determine in which part of the textbook includes SPS. The results of content analysis for the distribution of SPS among the parts of the textbook are presented in Table 4.7. Parts in the textbook are placed in the first main row; second main row represents the distribution of skills in each part and third main row shows the total number for SPS in each part with the percentages.

Table 4.7 Distribution of SPS in the parts of 9th grade physics textbook

	Parts in Textbook														Total
	AC	PR	LI	AE	PS	EX	BX	LD	AT	FG	HW	DM	CH	TB	
Sci.Com.	2	1	29	0	0	0	0	3	0	2	4	0	0	0	41
Infer.	39	20	1	3	1	0	0	1	0	1	1	0	0	0	67
Dfn.Cnt.V.	2	3	0	0	12	0	0	0	0	0	0	0	0	0	17
Exper.	1	13	2	1	0	0	2	1	11	1	0	0	0	0	32
Obser.	50	19	0	3	0	0	1	0	0	0	0	1	0	0	74
Hypot.	1	7	1	1	1	0	0	0	0	0	0	0	0	0	11
Model.	18	37	1	1	6	15	1	0	0	0	0	0	0	1	80
Meas.	42	66	1	12	10	0	9	1	1	1	0	1	0	2	146
Class.	7	40	3	8	0	0	0	3	0	4	1	3	6	2	77
Pred.	30	6	0	2	0	0	0	0	0	0	0	1	0	0	39
Col.Int.D.	62	26	30	11	4	2	2	2	0	1	4	2	0	2	148
Total SPS	254	238	68	42	34	17	15	11	12	10	10	8	6	7	732
NA	0	308	0	111	0	3	16	3	0	7	1	0	1	2	452
% in SPS (n=732)	34.3	32.1	9.2	5.7	4.6	2.3	2.0	1.5	1.6	1.3	1.3	1.1	0.8	0.9	98.8
% in all (n=1184)	28.6	26.8	7.7	4.7	3.8	1.9	1.7	1.2	1.4	1.1	1.1	0.9	0.7	0.8	82.4

(Sci. Com.: Scientific Communicating, Infer.: Inferring, Dfn.Cnt.V.: Defining-Controlling Variables, Exper.: Experimenting, Obser.: Observing, Hypo.: Hypothesizing, Model.: Modeling, Meas.: Measuring, Class.: Classifying, Pred.: Predicting, Col. Int. D.: Collecting-Interpreting Data. AC: Activity, PR: Paragraph, LI: Let's Investigate, AE; Assessment & Evaluation, PS; Problem Solving, EX: Example, BX: Box, LD: Let's Disscuss, AT: Attention, FG: Figure, HW: Homework, DM: Let's Do More, CH: Chart, TB: Table.)

According to Table 4.7, SPS are mainly covered by the activities (%34.3) in the textbook. After "Paragraphs" (%32.1) in the texts, the parts of "Let's Investigate" (%9.2), "Assessment and Evaluation" (%5.7) and "Problem Solving"(%4.6) also include SPS. On the contrary, the parts of "Figure", "Project", "Do You Know This" and "Context of Chapter" are not included in the table, because they contain 1.6 percent of SPS in the textbook. The interpretation of Table 4.7 skill by skill will be given in the following paragraphs while mentioning representation of SPS in the textbook.

The results of content analysis shows that collecting-interpreting data is the most included skill in the textbook. Experimenting is the second skill which is highly involved. The skills which are periodically covered in the textbook are modeling, classifying, observing and inferring. Scientific communicating, predicting and experimenting are occasionally involved in the textbook. Rarely mentioned ones in the textbook are defining-controlling variables and hypothesizing. The details about the involvement of these skills are presented in Table 4.8.

Table 4.8 presents the frequency distribution of SPS in chapters of 9th grade physics textbook published by MONE. The names of chapters are placed in the first main row with their abbreviations. In the second main row, the frequency distributions of SPS per chapters are given with the detail of the domains they belong to. The numbers in brackets represent the frequency domains; Knowledge-Based and Skill-Based Domains. For example, there are 19 measuring units involved in the chapter of Properties of Matter; 14 of these are knowledge based whereas 5 of them are skill based units. In the last main row, totality and percentages of SPS in the chapters are given. The total number for frequency in knowledge (T in KB) and skill based (T in SB) are also presented under the "Total" line. In the following line, the numbers of units which do not include any SPS are given. Finally, the percentages of each skill among SPS and all units (sum of SPS and NA units) in the chapters are presented in the last two lines. The total number of frequency for each skill is given in the eighth column; the numbers in the first line represent the sum of knowledge and skill based units which are given separately in the second line in brackets. The last column presents the percentages of skills in all SPS in the first line and all units (sum of SPS and NA units) in the second line in brackets.

Table 4.8 Frequency distribution of SPS in the 9th grade physics textbook

	Chapters						Total	% in SPS, (all) n=744 (n=1203)
	NoP	ENJ	PoM	FM	EM	WV		
Col.Int.D.	21 (4-17)	26 (0-26)	18 (0-18)	38 (1-37)	26 (0-26)	21 (0-21)	150 (5-145)	20.2 (12.5)
Meas.	55 (37-18)	21 (15-6)	19 (14-5)	18 (6-12)	24 (11-13)	11 (7-4)	148 (90-58)	19.9 (12.3)
Model.	11 (8-3)	10 (3-7)	11 (3-8)	23 (11-12)	19 (4-15)	8 (3-5)	82 (32-50)	11.0 (6.8)
Class.	4 (0-4)	16 (0-16)	47 (35-12)	7 (3-4)	0 (0-0)	5 (4-1)	79 (42-37)	10.6 (6.6)
Obser.	26 (17-9)	6 (0-6)	8 (1-7)	9 (1-8)	15 (0-15)	11 (0-11)	75 (19-56)	10.1 (6.2)
Infer.	8 (0-5)	11 (0-11)	6 (0-6)	16 (1-15)	10 (0-10)	16 (0-16)	67 (1-66)	9.0 (5.6)
Sci. Com.	6 (1-5)	14 (0-14)	3 (0-3)	9 (0-9)	4 (0-4)	6 (0-6)	42 (1-41)	5.6 (3.5)
Pred.	3 (1-2)	1 (0-1)	7 (0-7)	9 (0-9)	17 (0-17)	2 (0-2)	39 (1-38)	5.2 (3.2)
Exper.	18 (17-1)	4 (4-0)	4 (4-0)	2 (2-0)	4 (4-0)	1 (1-0)	33 (32-1)	4.4 (2.7)
Dfn.Cnt.V.	1 (1-0)	0 (0-0)	0 (0-0)	9 (2-7)	4 (0-4)	3 (0-3)	17 (3-14)	2.3 (1.4)
Hypot.	9 (7-2)	0 (0-0)	0 (0-0)	1 (1-0)	1 (0-1)	1 (0-1)	12 (8-4)	1.6 (1.0)
Total	162	109	123	141	124	85	744	100.0
Total in KB	93	22	57	28	19	15	234	31.5
Total in SB	69	87	66	113	105	70	510	68.5
NA	58	75	53	121	77	75	459	61.7
% in SPS (n=744)	21.8	14.7	16.5	19.0	16.7	11.4	100.0	
% in all (n=1203)	13.5	9.1	10.2	11.7	10.3	7.1	61.8	

(NoP: Nature of Physics, ENJ: Energy, PoM: Properties of Matter, FM: Force and Motion, EM; Electricity and Magnetism, WV: Waves. Col. Int. D.: Collecting-Interpreting Data, Meas.: Measuring, Model.: Modeling, Class.: Classifying, Obser.: Observing, Infer.: Inferring, Sci. Com.: Scientific Communicating, Pred.: Predicting, Exper.: Experimenting, Dfn.Cnt.V.: Defining-Controlling Variables, Hypo.: Hypothesizing. KB: Knowledge-Based Domain, SB: Skill-Based Domain.)

According to Table 4.8, the SPS are involved 61.8 percent of the 9th grade physics textbook. 31.5 percent of these skills are knowledge-based whereas 68.5 percent are skill-based. Conversely, 38.2 percent of excerpts in the textbook do not include any SPS. To begin with, collecting-interpreting data is the most highly emphasized skill (20.2%) in the textbook; 96.7 percent of this skill is in the skill-based domain, 3.3 percent is in the knowledge-based domain. It is involved in knowledge-based domain only in the Nature of Physics chapter. For example, it is mentioned in the paragraph as;

> While investigating an event relevant to physics, determining effecting or not effecting factors on this event is not always possible only by making observation. In such cases physicist collect data by making some experiments in natural environment or laboratory. In those experiments, like the experiments done in Science and Technology lectures dependent, independent and control variables are determined. By this means, the effect of independent variable on dependent variables using the control variables is tried to be explained. Physicists explain the data that are obtained from experiments by interpreting them (p.24).

In this excerpt, it is stated that scientists collect data, make experiments and determine variables. By this information students have idea about what scientists do, however the percentage of this type of knowledge is so small that can be negligible. On the other hand, collecting-interpreting data is involved prominently in the skill-domain. It is highly involved in the Energy chapter, Properties of Matter and Electricity and Magnetism. The reason behind being the most emphasized skill in the textbook is that it has four definitions in the codebook as: DSTP: Gathering qualitative and/or quantitative data depending on purpose; DSTM: Transforming the data into different forms such as table, graph and chart; DSR1: Interpreting the collected data; DSR2: Make generalizations according to interpretation of the collected data. The numbers of units with the percentages in the skill-domain for each code are: DSTP:29 (20.0%), DSTM:11 (7.6), DSR1:80 (55.2%) and DSR2:25 (17.2%).

The first code in the skill-based domain, gathering qualitative and/or qualitative data, is mostly emphasized in "Let's Investigate" part of the textbook in which students are asked to search about mainly daily life examples of concepts for deep understanding. The textbook suggests students search on internet, go to library or read scientific articles. Here are some examples for research questions from "Let's Investigate" part which ask students investigate:

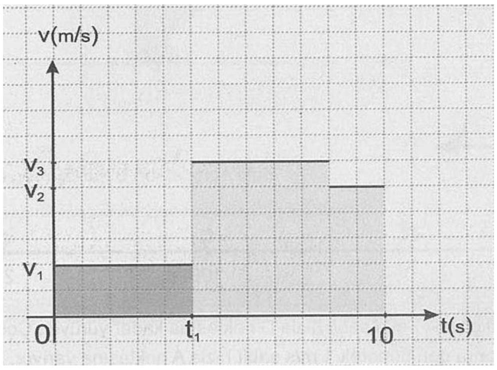
- Investigate the process of the laws of Gravitation and Conversation of Energy (Nature of Physics),
- How and in which areas, the properties of matter are used in industry and technology (Properties of Matter),
- Give daily life examples for motion with constant velocity and acceleration. Search for effects of change in velocity in the examples (Force and Motion),
- Role of renewable energy sources on the studies about decreasing the effect of greenhouse gases which cause global warming (Energy),

- Investigate how power switch of electric heaters and studying lambs work. Also investigate the corresponding element for the power switch in an electric circuit that you have learnt so far (Electricity and Magnetism),
- Investigate the travel of sound starting from the source to hearing; distinguish in which parts of its travel the sound behaves like a wave and make vibration (Waves).

Secondly, transforming the data into different forms such as table, graph and chart is included in the parts of "Activity", "Let's Investigate" and "Problem Solving". Students are asked to draw graphs according to the collected data in activities, fill in tables according to given or collected information, in some cases first fill in tables then draw graphs regarding data in the table and calculate the value of a quantity by using the properties of graphs. For example, students are leaded to solve a problem by using a graph in the "Problem Solving" part of the textbook as;

Problem Case

Physics teacher asks Büşra to find the distance an object travels, whose velocity-time graph is given below, to the starting point at the end of ten seconds. As a clue the teacher says that at the moment t_1 the object travels 100 m away from the starting point. Büşra finds the answer of the question by using this clue.
If you were in her place, how would you solve this problem?



The Procedure
According the graphic above, let's find how many meters is each of the identical squares which form the magnitude of the displacement till time t1.

……………………………………………………………………………………

Result

1. Can you find how many identical squares form the whole area that is bordered by velocity-time graph and the axis of time? If you can find, explain the procedure.

……………………………………………………………………………………

2. Find the distance of the object to the starting point at the end of the tenth second.

……………………………………………………………………………..

(p.141)

* Translated in English by the researcher

The third definition given for collecting-interpreting data is mostly emphasized one among other codes in the skill-based domain (55.2%). Interpretation of collected data, comparisons of results of an experiment with the predictions, make conclusions with respect to collected or given data are covered under the DSR1 code. In the textbook, this code is emphasized mainly in parts of “Activity”. This skill takes place in the textbook in different forms; it appears as interpretation of the results of observation, measurement, tables, collected qualitative data or previous experience one at a time. Moreover, it mostly appears as comparison of the results of observations, measurements or calculations with the predictions made before conducting them. The process is almost the same in the activities; students are asked to predict first, then observe or measure or make calculations and finally compare predictions with the results. For instance, this repeated structure in the textbook is like that;

Activity- Let’s Make a Distinction between Heat and Temperature

! Be careful while using spirit stove in the activity.

Equipment

2 thermometers, 2 beakers, 2 spirit stoves, Water (1.5 L), 2 tripods

Procedure

1. As shown in the photograph build the set up carefully by putting water into the beakers as one of them has water twice as much as the other.
2. Measure the temperature of the water in each beaker.
3. By discussing, make a prediction about the values indicated by the thermometers will be the same or not if heat is given to each of the beakers for equal periods of time.
4. Light the spirit stoves carefully.
5. By observing the values indicated by the thermometers at regular intervals, fill in the table similar to the following to your notebooks.

Time	t=0	t	2t	3t	4t
Temperature of lesser water					
Temperature of greater water					
Total heat given					

Result

1. Is there a difference between your prediction and observation? If there is, what is the reason of this difference in your opinion?
2. What is the reason of the difference between the temperature changes of the substances in the table although the same amount of heat is given?

(p.81)

* Translated in English by the researcher

The last definition for collecting-interpreting data is to make generalizations according to the collected or given data. This code indicates situations such as when students are asked to construct relations among variables due to collected data, make generalizations about quantities in physics. For example, students are expected to attain generalizations like "Gases have volume", "object, with a net force greater than zero accelerates" and "resistance of a conductor is proportional directly with length and type of conductor and inversely with cross section of it". It is mostly included in parts of "Activity" in the textbooks. However, the following paragraph after the activities usually explains the generalizations implied in the activity part. For instance, making generalizations according to collected data is given in the excerpt below;

Activity- Current, Voltage

Equipments

Bulb (1.5 V), Light socket, 3 batteries (1.5 V), Connection cables, Voltmeter, Ampermeter, Switch, Battery holder

Procedure

1. Make a group of 5 or 6 and share the tasks by considering the steps of the activity given below.
2. Set up the circuit as in the photograph.
3. Make a prediction about how the values of the voltmeter and ampermeter will change if the number of the batteries in the circuit is increased.
4. Read the values in the voltmeter and ampermeter by closing the switch. Write the predictions and the observed values to your notebooks by filling the table similar to the following one.

	Prediction			Observation		
	1 batt.	2 batt.	3 batt.	1 batt.	2 batt.	3 batt.
V						
I						

Result

1. Is there a difference between your prediction and observation?
2. Did the current in the circuit change when the number of the batteries was increased?
3. By considering the observation column in your table, can you tell that there is a correlation between the values of the voltmeter and ampermeter? What kind of correlation is this?
4. In your opinion, explain the meaning of obtaining a line as the sketched graph related with the observation?

There is a correlation between the voltage applied to the end points of the circuit and the current in this circuit. This correlation is directly proportional. When the voltage is doubled, the current is also doubled. Therefore, the ratio of the voltage to the current remains constant. This ratio is called the resistance of the conductor between the end points of the voltmeter. Resistance is shown by the symbol R. George Simen Ohm revealed this fact for the first time. Hence, this law is called Ohm's Law as it is taken from his name. This law is expressed with the equation of R= V/ I

(p186)

* Translated in English by the researcher

Measuring is the second skill highly covered in the textbook. According to Table 4.8, 37.2 percent of this skill belongs to “Nature of Physics” chapter and the coding units in this chapter are mostly paragraphs. The emphasized domain in this chapter for the skill of measuring is knowledge-based one. The ratio of codes in this domain in “Nature of Physics” chapter to the sum of all codes in the same domain is 41/100. It is also same for measuring skill in the sum of all chapters; the skill is emphasized mainly in the knowledge-based domain (60.8%). There are two main codes that are included in mentioned domain. One of them is giving information or asking questions about the units of physical quantities which is in declarative dimension of knowledge-based domain. Due to content analysis, the textbook gives information about the units of fundamental and derived physical quantities such as mass, volume, length, density, energy, work, current, force and so on in all chapters. The second one is giving information about how to measure any physical quantity that placed in the procedural knowledge dimension. It takes place in the textbook as;

> When any solid matter which is water insoluble is put into water, there is a change in the water level. The difference between the first and the last levels of the water is the measurement of the volume of the matter that is put into the water. If the volume of the water before the solid matter is put is shown as V1 and the total volume after the solid matter is put is shown as V2 then the volume of this solid matter is found as V= V2 – V1 (p. 103).
>
> The potential of a battery’s (+) and (-) poles are different from each other. Therefore, there is a difference of potential between the poles of a battery. The difference in potential has a tendency to be balanced. This tendency causes a current occur between the poles of the battery. In the SI unit system, the unit of the potential difference is volt and it is shown as V. This is measured by the equipment called voltmeter (p. 183).
>
> In balanced scales, we learned that in order to make mass measurements unit masses are utilized. In digital scales however current is used for this measurement. In these scales the current is adjusted according to the mass that is put onto these scales. The adjusted current is reflected as numbers in the scale’s screen. So the mass measurement takes place (p. 27).
>
> The magnitude of an earthquake is related with its energy. Beside the energy, earthquakes have also a ground shake. This shake is measured by the Richter scale. Its range is from 1 to 9 (p. 228).
>
> Temperature is the reflection of heat, a characteristic that is felt and it is not energy. It is measured by a thermometer. In other words, temperature is the value of the average motion in the environment. So if the temperature is high, the molecular motion in the environment is also expected to be high (p.82).

(Translated in English by the researcher)

The 39.2 percent of measuring codes belongs to skill-based domain and the coding units are mainly the steps in the activities. Students are asked to perform the measurements given in the steps of activities. Activities in the textbook explain how to measure step by step and even direct students to note the measurements. In most of the activities students are expected to follow the directions. For example, an excerpt given below is coded as measuring in the skill-domain; it asks students to construct a measurement tool which determine the ratio of water in milk. However, what students need is to follow the steps in order to construct the tool. The excerpt is;

Activity Determining Water ratio in Milk

A group of students wonder about the water ratio of milk in different brands sold in the markets. In order to determine this ratio they want to design an instrument and use it. If you were in this situation, what would you do to solve this situation?

Equipments

Experiment tubes, Graph paper, Beaker, Band, Distillated water, Pure milk, A small stone

Procedure

1. Make a group of 5 or 6 and share the tasks by considering the steps of the activity given below.
2. In order to sink the experiment tube on which you stick band, enough into the water, put the small stone into it.
3. After putting some water into the beaker, put the experiment tube into it. Write 100 to the sinking level.
4. After putting some milk into the beaker put the experiment tube into it. Write 0 (zero) to the sinking level.
5. Scale the tube by putting %10, %20, %30 … water to the milk in the beaker.

Result

1. Can the percentage of every mixture of liquid prepared by this way be calculated?
2. What is the meaning of different sinking levels at the experiment tube for different mixtures?

(p. 109)

* Translated in English by the researcher

In Table 4.8, the total number for distribution of SPS is given in the eighth column showing how many of them belong to each domain in bracket. Results, given in Table 4.8, show that three skills namely measuring, experimenting and hypothesizing are included in the textbook in the knowledge-domain, only one skill, classifying has balance in domains and other skills are involved in the skill-based domain.

One of the skills emphasized mostly in knowledge domain is measuring which was explained above with example excerpts. The other one is experimenting in which the gap between two domains is the maximum. Similar to measuring and hypothesizing, codes of experimenting in knowledge-based domain is mostly involved in the paragraph coding units of “Nature of Physics”. In this chapter, the statement “scientists make experiments” is repeated in many paragraphs. Same example excerpt given for the collecting-interpreting data in knowledge-based domain also involves experimenting skill in the same domain. Moreover, almost all “Attention” parts in the textbook draw students’ attention to use the equipment’s safely during activities. These parts were also coded as experimenting in knowledge-based domain. Here are some examples from the “Attention” parts in the textbook that are translated in English by the researcher:

- Since 220 V of city electricity will be used during the activity, be careful of the electric shocks (p. 32).
- Be careful that the hot water is at a degree that will not burn your hands (p.77).
- Be careful that the injector used during the activity is without needle (p. 96).
- If an electric accident occurs in the laboratory, you need not to panic. In such a case the first thing to do is closing the current of the electric circuit. For this, we can disconnect the plug; open the fuse or the switch of the circuit. Until you cut the current or isolate yourself, do not touch your friend who has electricity shock (p. 181).

Experimenting which is synthesis of all other SPS is only involved in one activity. However, the codebook makes distinction between following steps of an experiment and designing an experiment. This activity coded as experimenting gives the steps and expects students conduct the experiment step by step. Here is the activity which is the only one for inclusion of the experimenting skill in the textbook:

Activity 7 Let’s Hypothesize

Equipments

Plastic bottle of water, Insulating tape, Nail, Water

Procedure

1. Make a group of 5 or 6 and share the tasks by considering the steps of the activity given below.
2. Punch three holes on the plastic bottle of water in the same vertical direction. Close those holes by using the insulating tape.
3. Put water in to the bottle and close its cover.
4. Make predictions about what will happen if you remove the insulating tape covering the topmost hole.
5. Observe what will happen when you perform this step.
6. Was your prediction true? Your answer will be yes or no. How can you explain the reason of this? (Those explanations will be your hypotheses.)
7. In order to validate these hypotheses, perform the experiment again by opening the other holes on the bottle.

Conclusion

1. Why are the experiments required for the testing of the hypotheses?
2. Can you claim that a hypothesis is good or not? Why?

(p.39)

* Translated in English by the researcher

The situation for hypothesizing is similar to experimenting in means of being included in knowledge-based domain and mainly in “Nature of Physics” chapter. Likewise, hypothesizing is involved in the texts stating that “scientists make hypotheses”. The previous excerpt from an activity is also an example for hypothesizing in skill-domain. It is the only one which informs students that their explanations for observation are also the hypotheses. On the other hand, percentages of these skills have a slight difference; experimenting is covered in the textbook by 4.4 percent, whereas hypothesizing is 1.6 percent. In addition, hypothesizing is the least included skill in the textbook.

The skill of classifying in the textbook has balance between knowledge-based (53.2 %) and skill-based (46.8%) domains. That means textbook informs students about classifying skills as well as expects them make classifications. “Properties of Matter” includes this skill mainly in knowledge-based domain; 83.3 percent of classifying codes in this domain belong to the mentioned chapter. There is only one code cited for classifying in this domain which was defined as “Informs about classification; its criteria, and/or common and/or different specifications that is made before”. Texts in the chapter inform students about matter, classification of matter, similarities or difference of these classifications and so on. For example, paragraphs coded in knowledge-based domain of classifying are;

> As we can classify the matters as observable and unobservable, also we can classify them according to their common structural properties. One of these common properties is the states of the matters in natural environment. Matters are found in solid, liquid, gas and plasma state in nature. For instance, in the water cycle, snow or hail is the solid state of water; rain is the liquid state and cloud is the gas state of water (p.94).
>
> As we can classify the matters as compressible and incompressible, also we can classify them if they can or cannot do translational motion and can or cannot be affected by magnet.
>
> Translational motion is the movement of the molecules of the matter changing their position without any rotation. Think about in which period of the water cycle, the little water bulb do the translational motion (p.96).
>
> (Translated in English by the researcher)

The skill-based codes are mainly from the chapter of “Energy” (43.2%) and “Properties of Matter” (32.4%). The parts in the textbook that include classifying in skill domain are tables in text, and “Let’s Investigate”, “Let’s Do More” and “Let’s Discuss” parts. The classifying skills takes place in the 9^{th} grade physics textbook as;

Let's Investigate

In this table, various energy sources and some assessment criteria for these sources are given. Fill in the table by drawing a similar one on your notebook.

Energy Sources	Cost	Effect to environment	Reliability	Renewable	Un-renewable
Coal					
Windmills					
Sun reactors					
Nuclear Energy Stations					

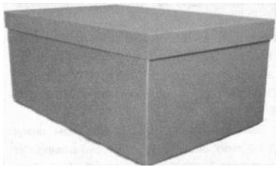
According to the table, investigate the advantages and disadvantages of renewable and non-renewable resources. Decide which energy source you will prefer according to the result of this investigation.
Share your results with your friends.
Nowadays, energy is low cost, not harming the environment, renewable and reliable. According to the activity above, it should be concluded that the wind power is the energy source that has these qualifications. Besides, what do you think about the role of climate and natural structure of the countries in determining the energy source that they would prefer? Let's find answer for this question by an activity.

(p.73)

* Translated in English by the researcher

The gap between domains in the skill of modeling is also close to each other; they are 40 percent for knowledge-based domain and 60 percent for skill-based one. The definition of modeling includes mathematical equations in the codebook. That is why mathematical symbols and equations which express the relations among physical quantities are coded as modeling in knowledge based. These coding comprises 72.8 percent of knowledge-based domain units in modeling. 27.2 percent belongs to the statements which indicate the importance of modeling in physics and that scientists make models. Similar to knowledge about mathematical equations, units which expect students use these equations in order to explain the relationship between quantities are coded in skill-domain. There are 40 coding units expecting students use mathematical equations are signed as modeling unit. There is only one activity in the textbook which ask students convert a form into another in such a way that it will represent the original one. Here is the only example in the textbook which intends to let students make a model;

Activity / Make Modeling



Tools and Devices
One piece of closed box, Measure, Calculator,
Graph paper
Procedure
1. Make groups of five or six people and assign duties by taking the following activity steps into consideration.
2. Try to collect some data about the inside shape of the given box together with your group members.
3. By using collected data, draw a model for internal shape of the box that can explain it best.
4. Discuss with your group members about the relationship between the model and the data.

Draw a conclusion
1. Compare your model with model of other groups.
2. Can you say which model is the best? Why?
3. Are there any similarities between your and scientist's modeling process?

(p. 42)

* Translated in English by the researcher

The skills of observing, inferring, scientific communicating, predicting and defining-controlling variables are involved mainly in skill-based domain. The gaps between the domains in these skills are very large except observing and defining-controlling variables. Nevertheless, there is no balance in domains for observing and hypothesizing. The skills of observing and defining-controlling variables in the textbook consist of 19 (25%) and 3 (17.7%) knowledge-based codes and 56 (75%) and 14 (82.3) skill-based codes. The knowledge-based skill comprises less than 3 percent of the total codes of the skills of inferring, scientific communicating and predicting. Therefore, the textbook cover these skills almost never in the knowledge-based domain, but only in skill-based one.

Making observations, inferences and predictions take place in the "Activity" part of the textbook. The structure of the activities is almost the same; they are composed of three subtitles as "Equipment", "Process" and "Conclusion". Observing and predicting are mainly covered in the "Process" part of the activity where inferring is covered in the "Conclusion" part. Students are expected to follow the steps in activities as setting up the equipment, making prediction about result of the activity, performing the directions; observing, making calculation, measuring etc. and finally interpreting the results and making inferences. However, the total percentage of these skills in the textbook is 15.0 and total percentage of them among other skills is 24.3.

Defining-controlling variables are mostly emphasized in "Problem Solving" part of the textbook asking students determine the dependent, independent and controlled variables in a problem case. However, the percentage of this skill in the textbook is 2.3 among SPS which is very small. Similarly, scientific communicating is emphasized in only one part of the textbook that is “Let’s Investigate”. After stating the subject of the investigation in this part, students are asked to share their findings with others. However, these sharing include only the collected data from sources like internet, scientific articles and so on; they do not belong to students’ own experiences on experimenting or any scientific activity.

To sum up, textbook highly includes collecting-interpreting data and measuring skills whereas almost never includes defining-controlling variables and hypothesizing. The skills of measuring, experimenting and hypothesizing are involved mainly in the knowledge-based domain. Classifying has balance in the domains in terms of being emphasized. Observing, inferring and predicting are covered mostly in the steps of activities in the textbook. Figure 4.2 represents briefly the frequency level of skills in the textbook as a summary of this section.

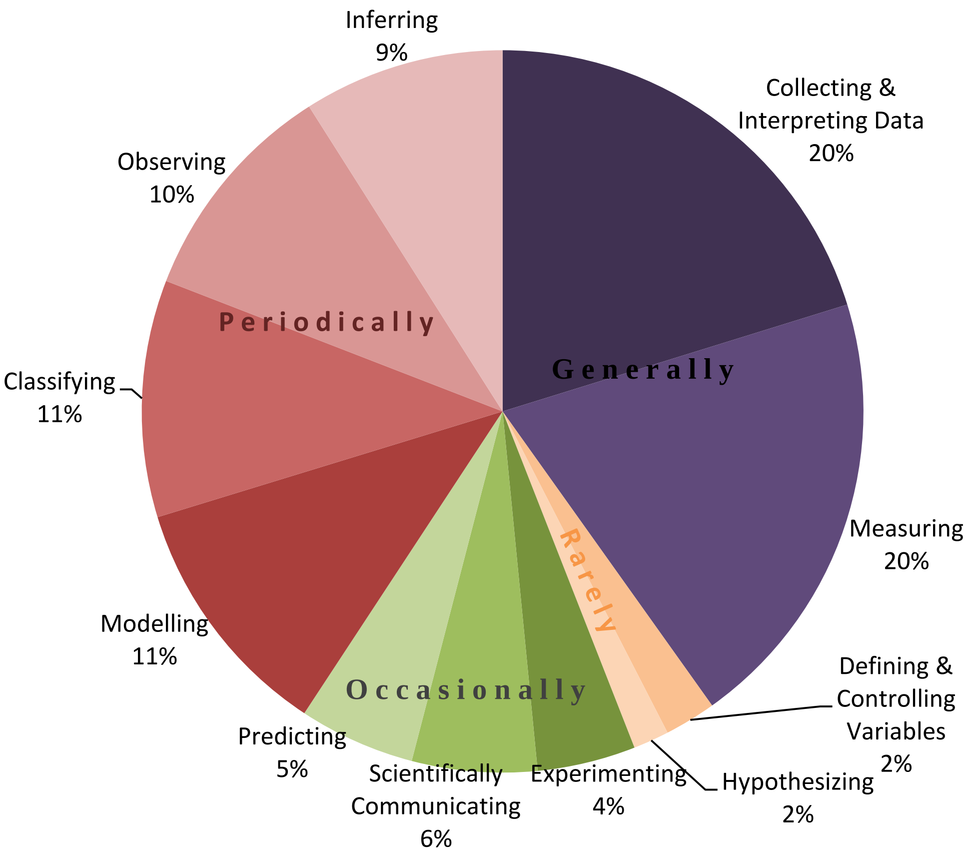


Figure 4.2 Frequency levels of SPS (n=744) in the textbook

4.3 Representation of SPS in the 9th Grade Physics Lessons

In this section, findings of third research problem are presented. According to the research problem, the lessons of three physics teachers were observed during the chapter of “Energy”.

Therefore, the results given in this section are limited by the chapter of “Energy”. Teachers who were selected to participate in this study were named as T2, T3 and T5. Information about these teachers was given in the section of “3.2.3.b the profile of teachers” in Chapter 3. Lessons of physics teachers are different from each other although they cover similar science process skills. In the following paragraphs, brief information about general flow of these three teachers’ physics lessons is given and then the findings of the analysis of observation are presented.

Teacher T2 mainly uses power point presentations which he prepares for his lessons and occasionally asks students demonstrations of some activities in the physics textbook. He follows the 9th grade physics textbook during his lessons. Besides, he gives daily examples not mentioned in the textbook and point out their connections with physics. In general, he is more active than students during lessons.

Teacher denominated as T3 starts the chapter in the laboratory. He makes students work in groups to conduct activities in the textbook. Each activity is assigned to one group. Students are expected to make the activities in the first two hours at the beginning of the chapter. In the following hours, students present the activities they made in the order of appearances the activities during the “Energy” chapter. They also submit the activity report to the teacher before they make presentation. Students read the 9th grade physics textbook in the lessons; generally one student read the parts loudly. When it comes to activity part students who are responsible for the corresponding activity make presentations as explaining the activity and answering the questions of the teacher. The 9th grade physics textbook is followed during his lessons. The energy chapter is covered in the way that students read the book loudly; they make presentation of activities and discuss them directed by teacher’s questions.

The teacher named as T5 generally gives daily life examples and links them with corresponding physics contents. She almost always creates a discussion environment in the classroom. For the chapter of Energy, she assigns volunteer students to prepare presentation about types of energy sources. Students investigate about energy sources and make presentations during Energy chapter. She does not use the 9th grade physics textbook regularly in the classroom for this chapter. Students are almost always mentally active and occasionally physically active.

The purpose of observations’ analysis is to reveal how science process skills are included in physics lessons. Video records of observations were watched and coded according to SPSCB. However, unit analysis is not defined in this analysis. The results reflect only the parts coded as SPS of the observation, so there is no any “Not SPS” in this part of the results.

According to analysis of observations of all teachers, the most included skill in physics lessons was modeling. It was also the most emphasized skill in the lessons of teachers individually. Collecting-interpreting data was the second skill which is highly covered in the lessons. However it was the second one only in the lessons of teachers T2 and T5, separately. The second skill highly involved in lessons of teacher T3 was measuring which comes in the fourth line of SPS distribution in all physics lessons. Classifying, measuring and scientific communicating were periodically involved whereas observing was occasionally involved in the lessons. On the other hand, there were skills that are almost never emphasized in these lessons; they were inferring, hypothesizing, defining-controlling variables, experimenting and predicting. Table 4.9 displays the frequency distribution of SPS among physics lessons for each teacher and also displays the sum of them.

Table 4.9 Frequency distribution of SPS in all physics lessons of the teachers

	Physics Classes												% (n=300)
	T2			T3			T5			Total			
	K	S	T	K	S	T	K	S	T	K	S	T	
Model.	2	39	41	0	24	24	0	22	22	2	85	87	29.0
Col.Int.D.	0	22	22	2	8	10	0	20	20	2	50	52	17.3
Class.	0	11	11	1	18	19	2	17	19	3	46	49	16.3
Meas.	14	0	14	12	9	21	4	1	5	30	10	40	13.3
Sci.Com.	1	3	4	0	15	15	0	12	12	1	30	31	10.3
Obser.	0	5	5	0	5	5	1	6	7	1	16	17	5.7
Infer.	0	2	2	0	2	2	0	4	4	0	8	8	2.7
Hypo.	0	2	2	0	0	0	0	3	3	0	5	5	1.7
Dfn.Cntr.V.	0	1	1	0	3	3	0	1	1	0	5	5	1.7
Exper.	0	1	1	1	0	1	0	1	1	1	2	3	1.0
Pred.	0	0	0	0	3	3	0	0	0	0	3	3	1.0
Total	17	86	103	16	87	103	7	87	94	40	260	300	100.0
% (n=300)	5.7	28.7	34.3	5.3	29.0	34.3	2.3	29.0	31.3	13.3	86.7		

(Model.: Modeling, Col.Int.D.: Collecting-Interpreting Data, Class.: Classifying, Meas.: Measuring, Sci.Com.: Scientific Communicating, Obser.: Observing, Infer.: Inferring, Hypoth.: Hypotesizing, Dfn.Cntr.V.: Defining-Controlling Variables, Exper.: Experimenting, Pred.: Predicting. KB: Knowledge-Based Domain, SB: Skill-Based Domain; TT: Total)

Table 4.9 shows SPS distribution in both knowledge-based and skill-based domain. The distribution is given for the lessons of each teacher in the columns. The abbreviations KB, SB and TT, under the lines of teachers' labels, show the distribution of SPS in the domains of Knowledge-Based and Skill-Based and in Total. In the end of teachers' column, the sums of frequencies of SPS for lessons of three teachers are given in the two domains and the sums of the frequencies in the domains are given under the heading TT under Total. Finally, the percentages of each skill in the total SPS of observations are presented in the last column. Similar to last two columns, last two rows show the total frequency value of domains for each teacher and the frequency of them in total SPS (n=300).

According to results of observations, modeling was the most included skill in the observed physics lessons of three teachers. As mentioned in the definition of modeling in section 2.1.1.k part, the mathematical equations are counted as models in this study. In the lessons of these teachers, the skill of modeling was emphasized since they included mathematical equations in order to express physics concepts and their relationships. For example, the concept of “Work” was stated as the multiplication of “Force” and “Displacement”. When these relationships were mentioned by using the equation “$W=F.\Delta x$”, the researcher coded as modeling in the first level that is “expressing the model that was constructed before”. This code is labeled as MSTP in the SPSCB. When students were asked to use the mathematical equations in order to comprehend the relationship between the physical quantities and to solve a problem, it was coded as modeling in the second level (MSTM). The modeling code in the second level states that “students explain the relationship among quantities by using a previously constructed model”. It was coded as modeling at the third level (MSTMP) when students were asked to make her/his own model.

According to Table 4.9, there were 87 modeling units involved in the lessons of teachers. Only 2 of them were in knowledge-based domain, others were in skill-based domain. Most of these skill-based units were raised through the situations when students used mathematical equations, second level code of the skill. There were also units from first level however; modeling code at the third level was not included in the lessons of the teachers. Students were not asked to make a model in the physics lessons, during the Energy chapter.

Skills of collecting-interpreting data, classifying and measuring were involved in the physics lessons in percentages of 17.3, 16.3 and 13.3, respectively. Collecting-interpreting data was involved mainly in the skill-based domain in physics lessons. Students were asked to collect data, draw graphs according to collected or given data and interpret the graphs that they draw or were given. Although three physics teachers covered this skill, the lessons of two teachers included more collecting-interpreting data units than teacher T3 did. Teacher T3 made students collect and interpret data via activities in the textbook. Students collected data according to steps in the activities and interpret them while answering the questions in the “Make a conclusion” part of the activities. He warned students to be careful while searching on internet to distinguish scientific knowledge from others. He informed students about web-pages that they can access reliable information during their investigation.

Teacher T5 involved the skill of collecting-interpreting data by making students to investigate the energy sources. Students collected information about the sources mainly via internet. Besides these investigations that were done out of the classroom, students accessed information about anything they discusses at that moment via their cell-phones by connecting internet. She also made students to draw graphs according to given data in problems and asked them interpret the cases and the graphs in the problems. Although some problems were based on some mathematical equations and so calculations, she insisted on interpretation of these values to understand the relationship among concepts. She emphasized making interpretations of cases in the problems. However, in her lessons, students did not collect data during the lesson and so did not interpreted the data they collected by activity or experiment.

In lessons of teacher T2, students were given different cases about the concept of “Work”. Some of these cases were performed by students in the classroom; some of them were given by photographs on power point presentation. These cases were asked to students to interpret regarding the concept of “Work”. Teacher T2 also asked student to draw graph according to a problem. Moreover, he gave some imaginary data about amount of some quantities, and expected his students to interpret these data. Similar to teacher T5, he did not let students to collect data in his physics lesson through an activity or an experiment.

The skill of classifying was included in the lessons of three teachers in Energy chapter and emphasized in the skill-based domain. It was the content that includes the classifying skill with the sub-headings as “types of energy”, “types of energy sources” and “types of thermometers”. However teachers had some difference in the inclusion this skill in their lessons. For example, teacher T3 asked students to classify the energy sources through the activities in the textbook. All classifying units in lessons of him belonged to the activities that students made in the laboratory and the situations when they discussed in the classroom. Teacher T2 made students classify energy or energy sources with classroom discussion. However, he only asked these types of energy or energy sources directly; ho did not give any daily life examples. For example, here is a part of discussion from his class about types of energy sources;

> Teacher: Gravitational force… Friends, actually if somewhere there is force and if this force makes an object move in the line of this force, it means an energy difference is here. So, from the moment a pen starts to roll and falls below this point, that is to say this point’s energy is higher than the energy of the base. In fact, this is due to the potential energy… Then let’s review the types of energy. You know that energy has been obtained from food. You know that heat is revealed when you rub your hands to each other. When you compress a spring and put an object in front of it, you see that the object flies away. **How can we classify the energy according to these situations encountered in daily life? It may be according to the source of the energy or how can we classify the energy directly? For example, what types of energy do we know?**
> Students: Potential energy, kinetic energy, mechanical energy, nuclear energy
> Teacher: What do we call to kinetic and potential energy?
> Students: Mechanical energy.
> Teacher: Mechanical energy is called to the sum of them. Then, the first is mechanical energy and how we classify it: Potential and kinetic energy. What else?
> Students: Heat Energy
> Teacher: Friends, heat is energy already, so let’s do not say energy additionally, and say heat. What else?
> Student: Can we say wind?
> Teacher: Wind Energy, what else?

Student: Electric
Teacher: Electric Energy, what else?
Student: Sun
Teacher: Solar Energy, what else?
Student: If these are energy, also water can be
Teacher: Water energy? Is there something as Water Energy?
Student: Don't we use the potential energy of water already?
Teacher: Yes, when electric energy is obtained from reservoirs, we use the potential energy of water. Thereby, I will not write it.
Student: **Teacher, if we don't write water due to the potential energy, then we shouldn't write wind due to kinetic energy?**
Teacher: **Good, we may not write wind energy due to kinetic energy. Now we list them, some of them can cause some questions in our minds; I do not write them as much as possible. But what your friend has said is true: actually wind energy is the energy released when the air molecules moves from one place to another and as you know when there is movement there is also energy. Thus, wind may prove to be a sort of kinetic energy. Later we will classify them separately, but now let's write them as they come to our minds.**
Student: Light
Teacher: Light, good, the sixth is the Light energy… Now, as we mention mechanical energy, potential and kinetic energy come to our minds. Heat is already energy on its own. Potential energy is equal to (EP = mgh, He writes on the blackboard) mgh. So these are mass, gravitational acceleration and height. Do you understand now why the object that I released here fell to the ground?
…
Look, there is a bottom-up height h. The potential energy at the top is high; the potential energy at the bottom is low. So if I take the reference as the bottom, there will be a movement from top to bottom. Then, I have been written the potential energy. Look at kinetic energy.
Student: ½ mv^2
Teacher: **Good, EK=½ mv^2. This is again mass and this is velocity. Now we can include the wind energy into the kinetic energy. Electric energy… Actually friends, if we draw a larger framework, there is Sun as the source of these energies. Now why Sun is there? Now you see how what we call light is achieved? How does it reveal?** In fact, light is an electromagnetic wave, electromagnetic wave as we know it. It is revealed by the stimulation of the atoms of the matter. So what does this stimulation mean, for example, think about an iron, you heat it up, you heat it by putting it on fire, after a while it becomes incandescent, light begins to spread. What have you done here? You stimulate the iron atoms, and transfer enough energy to them. By this way, electromagnetic light appears, look at its source, it is the atom. And we can add the Atomic Energy here. The source of electric energy can be wind, the waves, and the potential energy of the water. Energy derived from tidal wave event is considered in waves. In addition, nuclear power can be, it is on the agenda at this time in our country, and it was decided to be established. Here you will also get

electric energy but the source will be the atom, the nucleus of atom. You will break the atom and transfer the nuclear energy you create into heat, with the vapor pressure and you know from power stations, and get electrical energy in the same manner. When we have it as a separate class, then we cannot separate clear-cut. Can we obtain electrical energy from solar energy?

Students: Yes.

Teacher: For example, what do we do?

Students: By solar panels.

Teacher: **There are solar panels, solar batteries. From them, we get electric energy again. Nuclear energy and atomic energy is used in the same sense, ultimately the nucleus of the atom is the source of energy. So as a result, we can say that the source of all of the energy types that we use, benefit and see is Sun and they may be transformed into one another.** For example, if you compress a spring there is the elastic potential energy, and what will the elastic potential energy stored in the compressed spring do? It provides the movement of the object; it can be transformed into the energy of motion. Think of a ventilator. Electric energy in the ventilator… It is transformed into the energy of motion. Consider the light, electric energy comes to the light bulb, what is it transformed into? Light and heat... Then we will not forget that energy can transform from one type to another.

On the other hand, teacher T5 asked students to classify the energy through some daily life examples like saw or free-fall of Felix from space. Here are example classroom discussions of her lessons;

T: Yesterday a question came to my mind; in fact I would like to ask it directly. You know saw, don’t you? You cut wood with a saw. You start from a side of your desk. What are the factors? What kind of energies exposes?

S: Heat, heat energy

T: What about cutting that wood, which means helping to cut?

S: We create friction with kinematic. Friction energy cuts the wood.

T: Is there an energy type as friction energy?

S: Friction force! Friction force cut the wood, while cutting wood it makes friction so heat energy is created.

T: Do you remember that we tear a paper? In fact, what did we break down at that paper?

S: Bonds

T: We broke down bonds. What is saw doing by the help of that force? It is breaks down the bonds. Of course, as we discussed friction force also exists inevitably because of roughness, as wood is so hard. However, we should indicate that friction force is not only related to roughness.

…

T: Felix that we watched its video. It jumped from stratosphere. It observed the earth is moving when it jumped from there... While watching that video, it is said that it made free fall from spacecraft. Free fall, is there any friction during this motion?

S: There is

T: Additionally scientists worried about flaming possibility.

S: Because of friction

T: Now let’s check energy conversions of Felix starting from its jumping time till falling down.

S: Heating, speeding up, potential energy

T: Potential Energy

S: Decreasing

T: At the beginning while it was the maximum; man is falling dawn so fast, isn’t it?

S: Yes

T: Speed up, speed up speed up, sound

S: Speed of light

T: Of course not light velocity, it reached to sound wall. While falling dawn, it reached to sound velocity and then opened its parachute. Can you comment on this parachute opening time?

S: Is it possible to change its kinetic energy? Because it is slowing down...

T: Increment of its kinetic energy decreased, its kinetic energy was still increasing. However amount of increment reduced. What is the reason of that?

S: Air friction

T: Potential energy is reducing. Kinetic energy is increasing. But after a while, increment of kinetic energy is also reducing. Because air friction is increasing more and more… Well, why is air friction increasing?

S: Because parachute is opened.

S: Air molecules are denser at dawn parts

The percentage of measuring units in knowledge-based domain was 75.0 in all measuring units. The main code placed in measuring was about the units of physical quantities; the code is to inform students about the units of concepts. They were, for example, joule, calorie and watt in Energy chapter. All teachers gave information about these units; explained their components by using mathematical equations. For instance, they expressed the joule equals to” Newton.meter”. Besides giving the units directly, teachers gave information about history of units or how a unit is discovered like;

Teacher: James Watt was a Scottish scientist. The 19th century was the period during which the Industrial Revolution began. Of course, those days coal was precious metal. In industry, coal is something like a locomotive. Those days coal was always extracted from mine by manpower. But James Watt studied and produced an engine, as you see this is a huge engine. Of course, till then coal was carried only by buckets. Now there is the situation: we have energy but being able to work as soon as possible with this energy is important or not? This is also a topic of discussion… These things are done with horsepower mostly. It is attended that how much coal can be extracted and how many rounds it can take per unit time. James Watt produced the motor and he would sell it. For selling he needed to advertise it. So he based on the horses. According to this, I would like you to think that question: What is power? Is power a type of energy or transformation of it? Or is it a term which is used to show the existing relationship between time and energy?

…

Teacher: Developing the engine was not hard for him, but marketing was. He developed some techniques to market it. He would get the engine to things done which were done by people and animals until then, but at that time it was not really very easy to impose or convince the people about that. So, he needed to embody the job of the engine in the minds of people. He thought something like this: He observed that when one horse can carry 1 bucket of coal per minute, another one can carry 5 buckets per an hour. By this comparison, he stated that the horse that carried more coal in less time is more powerful than the other one. It is important that who is doing more work in a short time. Actually, the power unit, today which is called as horsepower, gets its name from the power of pony. One Horsepower is about 736 Watts. The power of a horse is considered as 0.7 power of a pony. The relationship between the power the horse and the pony created the concept of horsepower that we use today.

Teacher: Guys! When the units are considered, for example we say 1 meter. Everybody measured the length in meters previously, but now the length of the equator is considered, isn't it? You remember what was in the first unit, while learning about the basic quantities, we accept "second" as the duration of some number of the radiation which an atom makes. There was a benefit while using atomic clocks. But before that, of course there was not so much technology. Always there was an acceptance for units. In France, for example there was a metal with a radius of 39 mm. We accept it as 1 kilogram and we make it as 1 kg. The hours are all acceptances. Through Nm, when a force of 1N travels 1 meter path, it does a work of 1NM, we accept this as 1 joule.

25.0 percent of all measuring units belonged to the skill-based domain of measuring. Students of teacher T2 did not measure any quantity during Energy chapter in the classroom. Teacher T5 made students to measure the height of a bottle from the ground in order to calculate the potential energy of the bottle. However, students measured the height of the bottle without a meter, so they thought how to measure it and then measured by comparing the height of bottle with their handspan. The activity of measuring was happened only once in her lessons during the chapter, 10 course hours. In teacher T3' lessons, students made measurements through the activities in the textbook. They followed the steps of the activities to measure the intended quantities. In brief, the skill of measuring was involved mainly in the knowledge-based domain in physics lessons; students are taught the units of physical quantities rather than measuring them.

Scientifically communicating had 10.3 percent among all coded SPS in the physics lessons. It was especially covered by teachers T3 and T5. These teachers expected students to prepare presentations. Students of teacher T3 presented what they did in the first hour of the Energy chapter in the laboratory. An activity was assigned for each group of students, they were performed the activities in the laboratory in the beginning of "Energy" chapter. During the lessons they presented the activities they were responsible for. Depending on the activities in the textbook, students explained how they collected data, made measurements and followed the steps in the activities and answered questions of teacher and students. In the lessons of teacher T5, students made presentations about types of energy sources which were assigned them by teacher. Students shared the information mainly they collected through internet. They did not mention even the process of collecting data while they were investigating the energy sources.

Observing was covered by all teachers; however the percentage of it with respect to other SPS in total is only 5.7. It was included in the lessons of teacher T3 mainly because of following the textbook. Students made observations through activities. However, students who were assigned the activities which include the skill, made observations. In the lessons of teacher T2, students made observation in order to comprehend the concept of "Work". Teacher asked a few students to perform some activities in the classroom, and asked others to observe them. They were asked to classify the activities whether they are work or not according to their observations. Teacher T5 included observations in the demonstrations she or students did in the classroom. For example, a student presented a demonstration that shows the energy transfer through strings from a cub into another. Students were informed about aim of the demonstration. Then, they watched the motion of cubs; and answered questions of teacher due to their observation. Teacher asked the types of energies cubs had at different times during the demonstration.

Skills of inferring, hypothesizing, defining-controlling variables, experimenting and predicting were rarely mentioned during physics lessons in Energy chapter. Inferring is involved by all teachers in their lessons; teachers asked students about reason of events. They all use similar phrases like "What is the reason of …" In the lessons of teachers who follows the 9th grade physics textbook, skill of inferring is involved through the activities conducted or discussed in the classroom. Beside the activities including this skill, teacher asked students about reason of some observed events. For example, he released a board marker from a height of 1.5 meter, and asked students why it fell down. Another example from teacher T5, who is not following the textbook strictly, told that gardens are being watered in the morning or evening, not in the noon or afternoon. Then, she asked the reason behind this occasion and after listening students' answers she connected the reason with the Archimedes' firing the ships with concave mirrors at BC 250.

Hypothesizing was not emphasized sufficiently in the physics lessons according to Table 4.9. It is never included in lessons of teacher T3, in the lessons of teachers T2 and T5, hypothesizing was involved. Students were asked to find a solution for a specific problem or situation in the lessons of two teachers. However, students were not aware of what they were doing; hypothesizing. For example, teacher T5 asked students to find solutions in order to decrease the loss of energy in solar panel. In other words, they were asked to propose solutions so as to make solar panel available to work with 100% efficiency. They were answered, however it was not stated what they were doing was hypothesizing.

Defining-controlling variable was rarely included in the physics lessons during energy chapter. In the ones included in the lessons, students were asked to determine dependent and independent variables in an activity or in a problem. Students were just mentally active for this skill; they did not control any variable in an experiment or activity.

According to Table 4.9, experimenting is one of the skills that were not emphasized enough in physics lessons (1.0%). It is coded in lessons of three teachers; one is in the knowledge-based domain and other two are in the skill-based domain. The ones in the skill-based domain are in the first level of the skill; that is following the steps of a constructed experiment. In each one although they were from different classes, students just followed a structured pattern. Moreover, these experiments were done by only a few students as a demonstration in the classroom.

The skill of predicting was never included in lessons of two teachers, teacher T3 mentions the skill however the percentage of it in all SPS only in his lessons is 2.9 which is very small. It was included in the lesson of teacher T3 because he made students to perform the activities. Since the textbook asks students to predict the result of the activity in only one activity for Energy chapter, students made prediction in his lesson. Except from this situation, predicting was not included even in his lessons.

To sum up, modeling is the mostly included skill among SPS in the physics lessons during energy chapter. Modeling covered in these lessons mainly refers to the mathematical equations and usage of them in explaining relationships among physical quantities or in solving problems. Collecting-interpreting data, classifying and measuring are periodically involved in the lessons of three teachers. The skills of scientifically communicating and observing are occasionally covered whereas the skills of inferring, hypothesizing, defining-les, experimenting and predicting are rarely mentioned during Energy chapter in physics lessons of teachers. Figure 4.3 represents briefly the frequency level of skills in the physics lessons as a summary of this section.

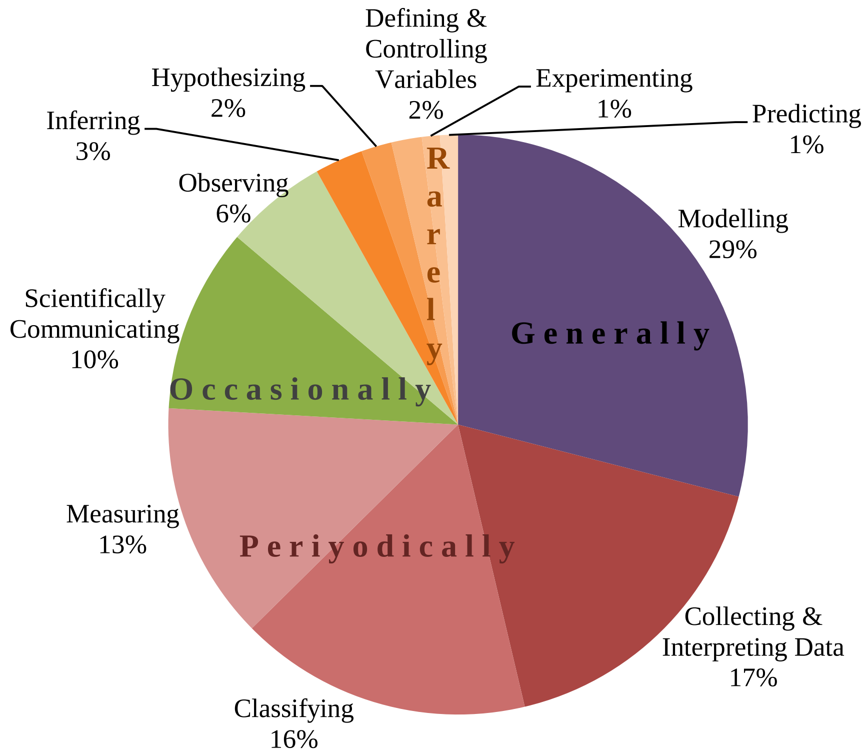


Figure 4.3 Frequency levels of SPS in all physics lessons of all teachers in Energy chapter

4.4 Comparison of Science Process Skills' Representations in the 9th Grade Physics Curriculum, Textbook, and Lessons

In this section, findings of the 9th grade physics curriculum, the textbook, and physics lessons are compared in order to reveal the consistency among them. Content analysis is applied to the curriculum and the textbook, transcriptions of all observed physics lessons of all teachers in Energy chapter. All of them are analyzed with respect to SPS. In this part, they are compared in order to answer the fourth research problem of this study: To what extent are 9th grade physics curriculum, textbook and lessons consistent to each other in terms of science process skills?

The 9th grade physics curriculum and the textbook are compared for all parts they include, however only the Energy chapter is compared for physics lessons. So, in order to compare the physics lessons with curriculum and textbook, only the Energy chapter is considered. Therefore comparisons of these components are given in two sections. First one is comparison of the physics curriculum and the textbook with respect to their inclusion of SPS. Second one is comparison of the physics curriculum, the textbook and physics lessons in Energy chapter with respect to their inclusion of SPS. Comparisons of the findings are presented from general to specific; it starts with inclusion of SPS in general for all components and then continues with the comparison of findings in knowledge-based and skill-based domains. Finally, the levels, being only physically active, only mentally active or both physically and mentally active, in the skill-based domain are compared.

4.4.1 Comparison of 9th grade physics curriculum and 9th grade physics textbook

Findings show that the curriculum and the textbook have specific skills in common that they emphasize, whereas they have certain gaps in particular skills. To begin with, collecting-interpreting data is the mostly involved skill in both of them. Classifying is the only skill which has the same percentage (10.6) for the curriculum and the textbook in all skills. The percentages of modeling and defining-controlling variables are also close to each other in both. However, skills of scientifically communicating, experimenting and hypothesizing are not included in the textbook as they are covered in the curriculum. On the other hand, skills of measuring and observing are included in textbook more than they are included in the curriculum. In addition, inferring and predicting are not covered in the curriculum, regardless of this textbook covers these skills, however in small than 10 percentages. Figure 4.4 presents comparison of SPS' percentages in the curriculum and in the textbook. Moreover, it also displays comparison of SPS' percentages in knowledge-based and skill-based domains, respectively.

It is important to keep in mind that there are interrelations among the skills. For example, experimenting includes almost all skills in the framework of this study. When experimenting is coded in a text, it means all skills are coded as well. However, because of the fact that experimenting covers other skills, there is no need to code other skills. Some skills also include others; for instance, measuring, inferring, predicting can cover observing, hypothesizing covers predicting, defining and controlling variables can cover measuring, observing, and so on.. These interrelationships make coding confusing when the rules are not set definitely. In this study, texts are coded with the most comprehensive one that is involved. For instance, hypothesizing is a systematic kind of predicting; however it does not mean that all predictions are hypotheses at the same time. Hypothesizing covers predicting by meaning, so when a text is coded as hypothesizing it means it also includes predicting. The text coded as hypothesizing is not re-coded as predicting. Similarly, collecting-interpreting data includes skills observing, measuring, predicting, and inferring. Yet, it is higher level skill compared to others; because it is a combination of other low-level skills. The rule is still valid; if a text is coded as collecting-interpreting data, it is not coded by other skills.

While comparing the results of the curriculum, and the textbook the rule of coding a text by the highest skill as it is possible is applied. That means when a text is coded as experimenting, other skills are not coded for the text. Moreover, experimenting except being defined in the codebook, it has some prerequisites in order to be coded. For example, hypothesizing before designing an experiment and testing the hypothesizing are prerequisites of experimenting. If these conditions are not satisfied in the text, it is not coded as experimenting but can be coded as other skills like measuring, observing, collecting-interpreting data, even predicting. In this part of study, findings are interpreted according this rule.

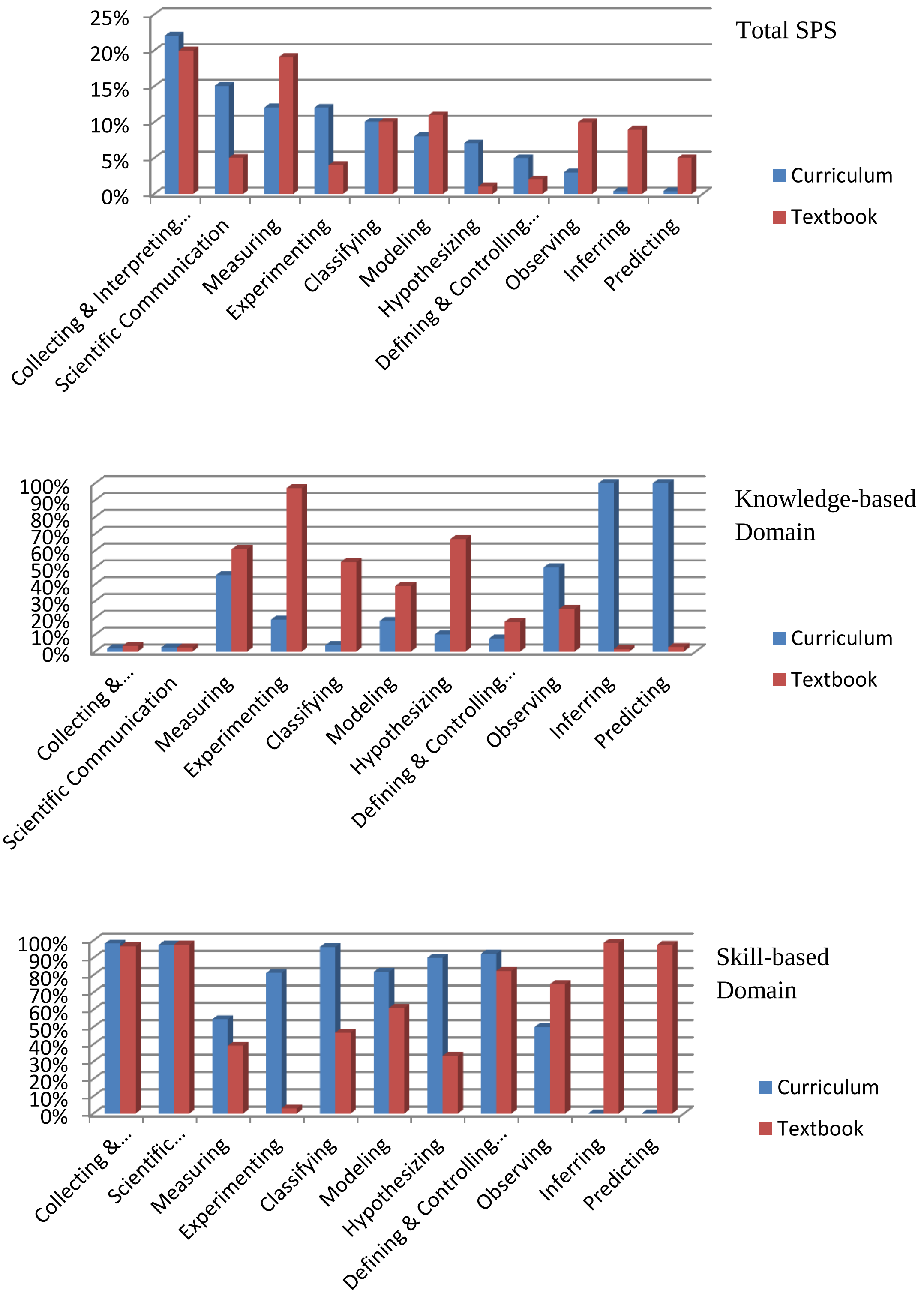


Figure 4.4 Comparison of SPS' percentages according to total SPS, knowledge-based and skill-based domains in the curriculum and textbook

The bar charts in Figure 4.4 are interpreted together in order to understand the relationship between the domains among the skills. It is important to interpret the Figure keeping in mind that these percentages of skills in knowledge-based and skill-based domain due to the curriculum and textbook are calculated accordingly the total coded excerpts in each skill. So, the 100% may be deceitful that the curriculum or textbook seem to be include the skill with 100 percent. However, the fact is that the skill can be involved by 20%, and all these may belong to skill-based domain. ın this situation graphs show 100% for skill-based domain in the corresponding skill. For example, skills of inferring and predicting have 100 % for skill based domain in textbook. however, that only means all coded excerpt belongs to this domain; that does not mean textbook include predicting and inferring with 100 percent.

According to Figure 4.4, collecting-interpreting data and scientifically communicating are mainly involved in the skill-domain in both the curriculum and textbook. There is a balance between the domains for the skill of observing in the curriculum. In the textbook, in contrast, it is mostly included in skill-based domain. In addition observing is not included in the curriculum as much as it is in the textbook. Similarly, inferring and predicting are involved in the textbook despite of being not covered in the curriculum. Skills of experimenting, classifying, modeling and hypothesizing are involved in the skill-based domain in the curriculum whereas they are mostly involved in the knowledge-based domain in the textbook.

The common characteristic of hypothesizing and predicting is that they do not include ordered codes in the skill-based domain. According to Figure 4.4, hypothesizing is poorly included in both the curriculum and the textbook with lower than 10%. However, hypothesizing mostly belongs to skill-based domain in the curriculum whereas it belongs to knowledge-based in the textbook. The skill of predicting is not aimed in the curriculum; in contrast the textbook includes it almost all in skill-based domain mostly in the “activity” parts. Even thought, the percentage of inclusion of predicting among all SPS in the textbook is lower than 5.

In order to be more precise in the skills, the findings are compared by focusing the levels in the skill-domain. The codes in the skill-based domain are in hierarchical order depending on being physically active, mentally active or both. The first level, being physically active refers to the situations when students are asked to follow the steps of observing, measuring and so on. In this level, students do not need to be mentally active, what they do is only carry out a given task. When students are mentally active in the second level; it is not necessary to conduct the skill physically for this level. However, the important point is to think about the skills; think about how to develop them or how to perform them well. The third level is the combination of first two levels; students are both physically and mentally active. In general, students are not given step by step procedures or not given explanations of questions already asked. In SPSCB, two skills do not have this hierarchy; they are predicting and hypothesizing. The findings for the comparison of the curriculum and textbook are given in the previous paragraph. In the following, comparisons of these elements for other skills are explained. Table 4.10 presents the percentages of levels in skill-based domain for the skills in the curriculum and in the textbook.

In Table 4.10, SPS are displayed in the first column; in the second one the compared elements are presented: curriculum and textbook for each skill. The third main column shows the percentages of coded units in levels expressed in the previous paragraph. The last column shows the total unit numbers of skill in the corresponding sample. NA is written for the second level of classifying, it means this skill is not defined in the second level.

Table 4.10 Percentages of skill-based levels for Energy chapter in the curriculum and textbook

		Level of Skills			
		Physically active %	Mentally active %	Both physically and mentally active %	n
Scientifically Communicating	Curriculum	12.8	12.8	74.4	39
	Textbook	97.6	0.0	2.4	41
Measuring	Curriculum	0.0	0.0	100.0	18
	Textbook	43.1	36.2	20.7	58
Experimenting	Curriculum	0.0	0.0	100.0	26
	Textbook	100.0	0.0	0.0	1
Classifying	Curriculum	100.0	NA	0.0	26
	Textbook	100.0	NA	0.0	56
Modeling	Curriculum	5.6	77.8	16.7	18
	Textbook	6.0	88.0	6.0	50
Defining-Controlling Variables	Curriculum	0.0	8.3	91.7	12
	Textbook	14.3	87.5	0.0	14
Observing	Curriculum	0.0	25.0	75.0	4
	Textbook	75.0	8.9	16.1	56
Inferring	Curriculum	0	0	0	0
	Textbook	42.4	1.5	56.1	66
Collecting-Interpreting Data	Curriculum	3.5	29.8	66.6	57
	Textbook	20.0	7.6	72.4	145

(n;Total unit number, NA; Not Applicable)

In this part, Figure 4.4 and Table 4.10 are interpreted together. According to them, the curriculum and the textbook are in balance in skill of collecting-interpreting data. Both of them involve mostly these skills rather than other SPS and emphasize the skill-domain. Moreover, distributions of collecting-interpreting data's percentages in the curriculum and the textbook are more or less similar in the level of skill domain. Likewise, findings show that classifying is included in two samples in the same percentage. However, there is no consistency in the domains; curriculum emphasizes skill-domain in contrast textbook emphasizes knowledge-domain. Nevertheless, Table 4.10 indicates that all SPS in the skill-based domain belong to first level in both the curriculum and the textbook. First level in classifying asks students to classify things or events that were classified. The third level (actually the second for classifying) asks students to create their own criteria and make classification according to it. However, making classification is not included in this level neither in the curriculum nor in the textbook. Therefore, they are similar in the inclusion of the skill of classifying.

Skills of scientifically communicating, experimenting, hypothesizing and defining-controlling variables are aimed in the curriculum; on contrary to curriculum they are not involved in the textbook. In other words, the curriculum aims to develop these skills, whereas the textbook supplies only information about them. Scientifically communicating as it is involved in the textbook is found highly in the first level of skill-based domain whereas it is found highly in the third level of skill-based domain in the curriculum. Thus, there is a mismatch between the inclusions of scientifically communicating levels in the skill-based domain. This means curriculum aims students to share any step in a scientific activity while textbook make students to share any collected data for instance mainly via internet.

There is a mismatch between the domains for skills of experimenting similar to scientifically communicating skill. For example for the skill of experimenting, curriculum uses verbs "discovers" and "discovers by experimenting" in the content objectives. Curriculum aims students make experiments in order to discover relationship between two physical quantities. For instance, Objective 2.2 in the chapter of Electricity and Magnetism states "discovers the variables affecting the force on a wire in a magnetic field by trying". Curriculum expects students define and control variables, observe the changes on the force by manipulating the variables, interpret the findings and draw conclusion about the factors. In brief, curriculum addresses experimenting. However, the activities in the textbook do not address the skill of experimenting in the skill domain. For instance, in the activity of corresponding objective students are asked "Have you ever think about the factors affecting the magnetic force? Let's discover it through an activity". The activity is given in cook book style; students are expected to follow the steps. They are not asked to make a hypothesis before performing the actions which is defined as a prerequisite for experimenting. Activities in the textbook neither involve the skill of hypothesizing nor experimenting. Moreover, activities are so structured that that do not lead students discover the intention of the objectives in the curriculum. Therefore, inclusion of experimenting in the curriculum is not consistent to the textbook. Table 4.10 also shows that there are 26 experimenting excerpts all involved only in the third level. On the other hand, there is only one experimenting unit in the textbook which is in the first level. Therefore, the textbook does not include experimenting skill as it is aimed in the curriculum.

Defining-controlling variables are included in skill-based domain in the curriculum whereas included in knowledge-based domain in the textbook. Figure 4.4 and Figure 4.1 shows that the curriculum covers this skill 5 percent in all skills. In addition it is covered by the textbook in 2 percent among all skills. So, the curriculum and the textbook are parallel in terms of ignoring this skill. Even percentages of defining-controlling variable are so small in the curriculum and in the textbook; there is a mismatch in domains of them. According to Table 4.10, the curriculum aims students focus on controlling variables that can affect the dependent variable and manipulate the independent variable in an experiment. However, in the textbook, this skill is not covered in the third level of skill-based domain which is both physically and mentally active, because textbook do not include the skill of experimenting.

Measuring, modeling, observing, interpreting and predicting opposite to skills of scientifically communicating, experimenting, hypothesizing and defining-controlling variables are involved more in the textbook rather than they are involved in the curriculum. These skills are mainly involved in steps of activities in the textbook; steps include making predictions first, then making observation and/or measurements and calculating a physical quantity by using mathematical equations, making inferences about the reasons of result of observation or measurement or calculation or comparison of them, respectively. According to the results given in this section about skill of experimenting, textbook include these skills while actually intending experimenting objectives in the curriculum. Now, comparisons in levels of skill-based domain in these skills are presented. Since predicting does not have ordered codes in skill-domain it is not explained in this section. In addition, the comparison for predicting is previously stated.

The curriculum aims students to be active both physically and mentally in skills of measuring and observing. Table 4.10 shows that in the curriculum these skills are highly in the third level however, in the textbook they are not so much involved in the same level. That is caused by the step by step procedure of the activities in the textbook. Students are expected to follow the direction in order to make measurement or observations. So, they do not need to be both physically and mentally active in the same time. This is another mismatch between the curriculum and textbook.

The skill of inferring is not included in the curriculum, so the units in neither domains nor levels of skill-based domain can be compared with the inclusion of it in the textbook. Only the textbook findings are explained; it is involved in the first and third level of skill-based domain in close percentages. The first level of inferring indicates that the textbook gives the explanation of the reason it is asked. Usually, these explanations are given just in the following line in the textbook. That makes students read the answer before thinking about the reason of observed or explained phenomenon, event or attained result.

The last skill which is involved in the textbook with a larger percentage than the curriculum is modeling. When only skill based domain is considered, the curriculum and textbook are parallel. The distributions of percentages in frequencies in levels are similar to each other. The second level comes first in two of them. That means the curriculum expects students to use mathematical equations in order to explain the relationships among the physical quantities. So, it is expected in the textbook in the same way. However, the curriculum still aims student to make an original model while the textbook reflects this with a lower percentage.

4.4.2 Comparison of the 9th grade physics curriculum, 9th grade physics textbook and 9th grade physics lessons in energy chapter

The findings of content analysis in the 9th grade physics curriculum, textbook and lessons in Energy chapter are compared in this section. These skills are compared in general first, and then percentages are given in knowledge-based and skill-based domain in bar charts. Figure 4.5 displays these bar charts of percentages of SPS in the curriculum, the textbook and the lessons. Similar to the way of presenting the findings in the previous section, after the bar charts, a table is given that shows percentages of SPS in each level of the skill-based domain for all elements compared. Then, Figure 4.5 and Table 4.11 are interpreted together in order to draw a comprehensible conclusion.

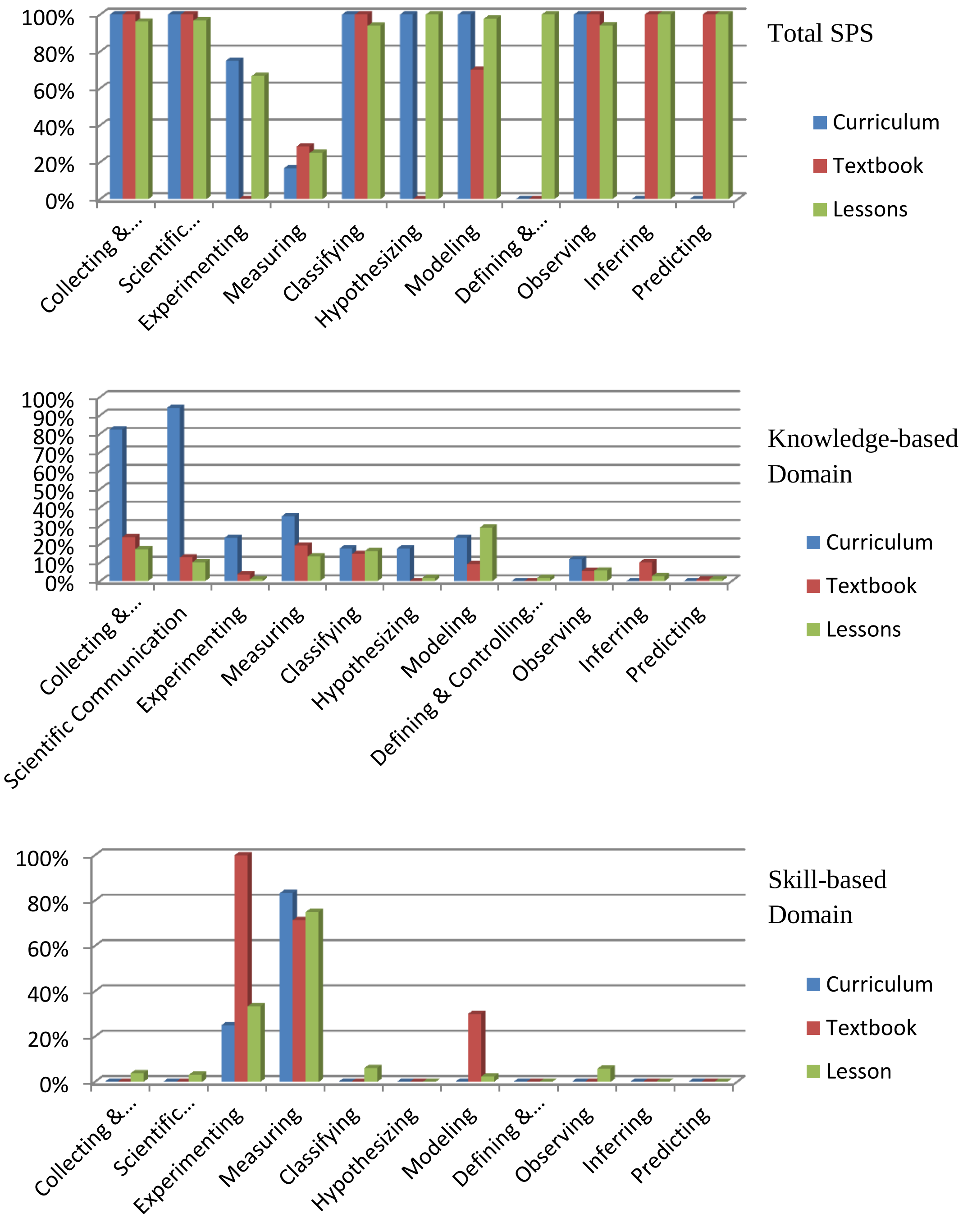


Figure 4.5 Comparison of SPS according to total SPS, knowledge-based and skill-based domains in the curriculum, textbook and lessons in Energy chapter

According to Figure 4.5, the sum of percentages of SPS in the curriculum (first bar chart in the figure) is more than 100. It is also mentioned in Table 4.3 that in the curriculum, each content objective includes approximately three SPS. So as difference occurred between the curriculum and the other elements in the first bar chart. The bar for the corresponding skill in the curriculum is taken into consideration by dividing three. Regarding this, the heights of the bars decrease to levels that are close the levels of the skills for the textbook and the physics lessons. According to first bar chart in Figure 4.5, skills of experimenting, hypothesizing and inferring have discrepancy in the height of the bars. That shows the gap between the curriculum, the textbook and lessons in involvement of these skills in the Energy chapter.

Second and third bar charts in Figure 4.5 show SPS except experimenting and measuring are included in the skill-based domain in all elements. So, results for experimenting and measuring are explained first, others are given after displaying Table 4.11. Measuring is highly involved in the knowledge-based domain in the curriculum, textbook and lessons in the chapter of Energy. That means, they are parallel in the skill of measuring in the mentioned chapter. Students are informed about the units about work, energy, heat and temperature. Experimenting is also mainly covered in the knowledge-based domain. However, the heights of bars are not close each other that means there is a discrepancy among the considered elements. The curriculum aims to inform students about making experiments; however the corresponding objective is coded as experimenting because of the skill objective attached to this content objective. Figure 4.5 shows that textbook include experimenting intensely in the knowledge-based domain so that it is more than in the curriculum and in the physics lessons. This fact also is reflected to the bars in the skill-based domain; the heights of bars for experimenting are not close to each other. According to the third bar chart in the figure, experimenting in skill-based domain is considered in both curriculum and lessons, however not in the textbook.

Table 4.11 presents the percentages of skill-based domain in the curriculum, textbook and physics lessons. Table 4.11 is similar to Table 4.10 in terms of presenting the percentages. The only difference is the third lines in each SPS that displays the percentages of skills in levels in the physics lessons.

Table 4.11 Percentages of skill-based levels for Energy chapter in the curriculum, textbook and physics lessons

		Level of Skills			
		Physically active %	Mentally active %	Both physically and mentally active %	n
Scientifically Communicating	Curriculum	18.8	6.3	75.0	16
	Textbook	100.0	0.0	0.0	14
	Lessons	83.3	0.0	16.7	30
Measuring	Curriculum	0.0	0.0	100.0	1
	Textbook	33.3	33.3	33.3	6
	Lessons	30	40	30	10
Experimenting	Curriculum	0.0	0.0	100.0	3
	Textbook	-	-	-	-
	Lessons	100	0	0	2
Modeling	Curriculum	0.0	100.0	0.0	1
	Textbook	14.3	85.7	0.0	7
	Lessons	38.8	61.2	0	85
Defining-Controlling Variables	Curriculum	-	-	-	-
	Textbook	-	-	-	-
	Lessons	0	100	0	5
Observing	Curriculum	0.0	0.0	100.0	2
	Textbook	50.0	0.0	50.0	6
	Lessons	68.8	0	31.3	16
Inferring	Curriculum	-	-	-	-
	Textbook	54.5	0.0	45.5	11
	Lessons	62.5	0	37.5	8
Collecting-Interpreting Data	Curriculum	0.0	28.6	71.4	14
	Textbook	38.5	7.7	53.8	26
	Lessons	10	12	78	50

Table 4.11 presents distribution of SPS's percentages in physics lessons is similar to distribution of SPS's in the textbook. Scientifically communicating, measuring, modeling, observing, inferring, and collecting-interpreting data show a strong similarity in the distribution of percentages in the levels of skill-based domain in the textbook and lessons. In this part, these skills are explained.

Scientifically communicating is mostly included in the third level in the curriculum; however, it is covered mostly in the first level in both in the textbook and lessons. Curriculum include this skill in a way that expects students to generate scientific communication not only communication. In the textbook, students are asked to share the information they attain via library or internet.

Measuring, similar to collecting-interpreting data, is emphasized in skill-based domain in the curriculum whereas it is almost equally distributed among the levels in both the textbook and lessons. Students are said what to measure and how to measure in the first level, think about making measurements in the second level and to measure any quantity in physics in the last level. However in the Energy chapter there is only one objective coded as experimenting in the skill-based domain.

Modeling is matched with only one objective in the curriculum corresponds to second level of the skill-based domain. Similarly, the textbook include modeling mostly in the second level. Moreover, the textbook also include modeling in the first level which indicates giving information about a model constructed before. In this case, it is the mathematical equation expressing the relationship between work and energy. Physics lessons include the modeling skill in the same way with the textbook; it is included mainly in the second level and also included in the first level but not in the third level.

Skill of observing is coded for two objectives in the curriculum in the third level. However, it is included in the different levels with different percentages in the textbook and physics lessons. Both of them include this skill in the first and third level almost in the same percentages. That means the textbook and the physics lessons are parallel for the inclusion of the skill of observing.

Inferring is not covered in the curriculum, however it is included in both textbook and the physics lessons. Moreover, they are almost equivalent in percentages in the levels of skill-based domain; the first level is mostly included and the third level in covered in both of them. On the contrary, the second level is not covered in neither of them. The difference between two levels is providing the answer of the reason of asked event or phenomenon just after the question without giving enough space to students to make inferences. It is the next line after the question in the textbook, and for the lesson it is teacher's explanation that gives the answer.

All these skills explained are parallel in inclusion of them in the levels of skill-based domain. Only the skill of collecting and interpreting data is similar in the curriculum, textbook and the physics lessons. They involve this skill mainly in the third level; students are expected to interpret the collected or given data. They are parallel in this perspective for the skill of collecting an interpreting data.

The skill of experimenting is included by three objectives in Energy chapter in the curriculum. They all belong to third level in the skill-based domain. In the textbook, it is not given any space for this skill. In spite of ignorance of textbook, skill of experimenting is included in physics lessons twice during the energy chapter. There is mismatch among the curriculum, textbook, and lessons.

Defining-controlling variable is different from other skills that the only skill which is ignored by the curriculum and textbook. These are occurred while students are making presentations about their submitted activity. Students are asked about variables affecting the result in the activity. In this way, they are forced to think about different variables effecting on same physical quantity.

In summary, SPS are compared among the 9th grade physics curriculum, textbook, and lessons in the Energy chapter in this section. The basic finding of this part is that the physics lessons is parallel to the textbook regarding the levels of skill-based domain. The other one is that skill of measuring is involved in knowledge-based domain in all, while others are mainly included in the skill-based domain. The curriculum, textbook, and lessons are close to each other only in skill of collecting-interpreting data.

CHAPTER 5

DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

This chapter presents a discussion of and conclusions drawn from the study findings, followed by the implications of these findings and suggestions for further research. The purpose of this study was to investigate the extent to which 9^{th} grade physics curriculum, textbook and lessons cover science process skills. Moreover, it is aimed to describe the extent these elements are in concordance with each other. To accomplish this purpose, 9^{th} grade physics curriculum and textbook are examined through content analysis which is a systematic research method used for coding textual information in a standardized way that enables researchers to make inferences about that information (Krippendorff, 2004; Weber, 1990). This study analyzed all pages of both the curriculum and textbook. 9^{th} grade physics lessons whose teachers were purposefully selected were observed during chapter of Energy. These teachers are ones who claim that she or he follows the 9^{th} grade physics curriculum with all aspects. Content analysis was employed to the transcriptions of physics lessons' observations. To conduct this study, the researcher developed Science Process Skills Code Book to analyze texts for their inclusion of science process skills. In the previous chapter, findings were given under four sub-headings parallel to research questions of the current study. In this chapter, conclusion and discussion of inclusion of SPS in 9^{th} grade physics curriculum, textbook, and lessons of three physics teachers are presented. Then, implications, and suggestions for further research are presented.

5.1 Conclusion and Discussion

5.1.1 Conclusion and discussion on the curriculum

In this section, conclusions based on the findings about the curriculum are presented. The conclusions and discussions are organized by considering direct and explicit information emerging from the study.

Conclusion 1: 9^{th} grade physics curriculum attempts to include SPS mostly in skill objectives, however one skill objective includes approximately three SPS which is not feasible.

The findings of this study show that 9^{th} grade physics curriculum has the potential to develop science process skills of students. It seems to be an enhancement over the previous ones in terms of its detail and emphasis on the interactions of skills and content. The emphasis on skills is very important because it offers the potential of moving the curriculum from being a theoretical implementation to one that has implications for students' daily lives. It may have the potential of transforming content of physics from being only a subject matter to a reality (Shamos, 1995). For instance, if students realize the implications of physics to their lives, then they may carry on attaining scientific knowledge and to use it in their decisions as citizens after they leave school.

Objectives in the 9th grade physic curriculum are given in two main headings; skill objectives and content objectives. Skill objectives are divided into four areas; (a) Problem Solving Skills; (b) Physics-Technology-Society-Environment; (c) Informatics and Communication Skills; (d) Attitudes and Values. Content objectives are given in six physics content; Nature of Physics, Properties of Matter, Force and Motion, Energy, Electricity and Magnetism, and Waves. One of major feature of the curriculum is that content objectives are matched with related skill objectives. It is strongly suggested in the curriculum to take attached skill objectives into account while considering content objectives. According to the findings in Table 4.3, there are 69 content objectives defined in the curriculum. 509 skill objectives are matched to these content objectives, so the total number for the objectives equals to 578. The findings show that 55 content, 183 skill objectives include SPS; after deleting the overlapping SPS, objectives in the curriculum include 219 SPS units. That means one content objective (content objective with attached skill objectives) includes three SPS averagely. The present study shows that the ratio of SPS to the objectives in the 9th grade physics curriculum makes the objectives not feasible in terms of developing SPS.

The combination of content objectives with skill ones can be confusing for teachers. Moreover, some skill objectives as mentioned before are not feasible to be observed in the classroom. It can be suggested to integrate the skill objectives with the content and rewrite for each chapter in the curriculum.

Conclusion 2: The curriculum includes mostly collecting-interpreting data, scientifically communicating and experimenting. Experimenting covers other skills indirectly in the curriculum.

The curriculum aims to develop students' collecting-interpreting data, scientifically communicating, measuring, experimenting and classifying skills more than modeling, hypothesizing and defining-controlling variables. On the other hand, it seems not to include observing, inferring and predicting. This is because these skills are hidden in the skill of experimenting. Experimenting, actually involve all other science process skills. The results of this study show that 9th grade physics curriculum covers other skills implicitly under the heading of experimenting.

5.1.2 Conclusion and discussion on the textbook

Conclusion 3: 9th grade physics textbook is highly structured; it includes SPS in step by step activity procedures. However, step by step procedures in activities are weak to develop SPS of students.

The results of this study indicate that in general, 9th grade physics textbook is highly structured in that it provides step-by-step detailed instructions in the activities. Activities were made up of three following components: “equipment”, “procedure” and “conclusion”. In the first part, equipment for the activity is given in detail. Then, students are asked to follow well-defined steps in order to attain the goals of activities in the procedure part. In conclusion, there are questions asking students make inferences and or interpretations according to observations, measurements and/or calculations. In the majority of activities reviewed, students are asked to follow the steps by using given equipment in order to attain a conclusion. In general, students are asked to manipulate materials, make observations and measurements, record results, make qualitative and quantitative relationships, draw conclusions, make inferences and generalizations, interpret the results, and share what they found in the activities which are communicating.

This result, having highly structured textbook, is consistent with the literature in science education (Fuhrmann, Novick, Tamir & Lunetta; as cited in Nieddere, et al. 2002; Germann, Hasking, & Auls, 1996; Soyibo, 1998; Tamir and Lunetta; as cited in Hanauer, Hatfull, Jacob-Sera, 2009). It is found that activities including step by step procedures and activities whose result is already known do not develop students’ SPS. Therefore, activities in the textbook can be concluded that they are not designed in order to develop SPS. Due to poor representation of SPS in the activities of textbook, it can be proposed to modify the step by step procedure activities to promote SPS of students. It is suggested to be open-ended investigations in order to facilitate the development of SPS in the literature (Soyibo, 1998). The more involvement students have flexibility in observing, measuring, designing experiments, hypothesizing and so on, the higher the level of process skills included according to the SPSCB. Lower levels of process skills are characterized by activities with directions including step by step procedures.

The activities in the textbook provide so many steps, explanations and crude exercises that little space is left to students for thinking. Wang (1998) explained this situation as it is almost a “dumb-down” strategy that merely betrays the fear that students will not “get” it, but the results is that it leaves no space for students to grow. Imagination and creativity are stifled by “hand-feeding” fashion of presentation (p.143). Moreover, the activities in the textbook are mostly hands-on activities. However, being so structured is an obstacle for developing skills of students. According to curriculum daily life problems that students solve by using physics is desired and they are different from traditional “experiments” that tend to be verification labs in which students seek the right answer. Instead of completing exercises from a chapter in the textbook, students need to solve daily life problems by themselves.

Conclusion 4: Activities in the textbook are weak to make students hypothesize or pose a testable question which is the starting point of science.

The activities in the textbook seldom provided opportunities for students to pose a question to be investigated; formulate a hypothesis to be tested; design observation, measurement, and experimental procedures; work according to their own design; or formulate a new question or apply an experimental technique based on the investigation they performed. They are explained how to make observations and measurements; they are like appended exercises rather than integral parts of the investigation. Students are rarely asked to use what they have learned to make predictions or hypotheses or to explain common natural objects or events. Similar to Tamir and Lunetta (as cited in Gerrnann, Haskins & Auk, 1996) stated that "If scientific inquiry is using one's own knowledge and experience to pose questions, solve problems, investigate natural phenomena, and construct answers or generalizations, then these manuals do not yet foster such activity", these activities are poor to develop students' science process skills.

Hypothesizing was found not to be included enough in the 9th grade physics textbook. Students were rarely asked to formulate hypotheses or propose solutions for given problems. However, generating hypothesis is very important for students developing science process skills; it is the first step in experimenting (Kwon, Jeong & Park, 2006). It is also stated that students develop a deeper understanding of concepts and skills when they make their own hypotheses. Although it is included by skill objectives in the curriculum, these objectives are not attached to a few numbers of content objectives. Nevertheless, the activities could include making hypotheses as a step in the activities similar to the step of making predictions before observing and measuring steps in activities.

5.1.3 Conclusion and discussion on physics lessons

Conclusion 5: Results of this study about physics lessons show that the teachers rely on textbooks more than they rely on the curriculum.

9th grade physics textbook influenced the inclusion of SPS in Energy chapter in the physics lessons more than the curriculum did. This finding is consistent with the studies stating that many teachers rely heavily on the assigned textbook to teach science content and how to teach (Costenson & Lawson, 1986). Textbooks principally define what topics and ideas are taught in the classrooms and how these topics are taught (Tyson, 1997). A study conducted 20 years ago found that 90% of all science teachers use a textbook 95% of the time (Harmes & Yager, 1981; as cited in Stern & Roseman, 2004). Study of Ball and Feiman-Nemser, (1988) indicated that many teachers count on curriculum resources like textbooks to provide them with some or all the content or the pedagogical content knowledge. Similarly, researches show that textbooks play a dominant role in teaching and learning science; Horizon (2001) found that 96% of teachers in grade 9 through 12 rely on commercially published textbooks, or programs. Moreover, 63 % of these teachers rely on only 1 science textbook most of the time. However, in Turkey teachers are expected to follow the textbook proposed by MONE. Textbooks in Turkey are extremely important for teachers as a bridge between curriculum and teachers. Therefore, the finding of present study is not surprising when the situation in Turkey is taken into consideration.

Conclusion 6: Physics lessons of 9th grade physics curriculum which aims to develop SPS of students take place in traditional classrooms not laboratories.

There are experimental procedures in the curriculum and also in the books which can be a good approach in viewing the SPS aspects if they are applied adequately in the classrooms. However, only one teacher used the laboratory only for a lesson hour in one chapter which is totally twelve lesson hours. This problem is mentioned in the study of Özden (2007) that one of the problems teachers have in Turkey is the less laboratory opportunities, it is doubtful that if these experiments are performed. Since teachers do not use laboratory because of many reasons, they have physics course in the traditional classrooms. These traditional classrooms setting are not suitable for creating an environment for students to develop science process skills.

5.1.4 Conclusion and discussion on gap between curriculum, textbook, and lessons

Considering the findings of content analyses, gaps are determined among the 9th grade physics curriculum, textbook, and lessons. In this part, gaps among curriculum, textbook, and lessons with the possible reasons behind them are discussed through the weakness of the curriculum, textbook and lessons, respectively.

Conclusion 7: 9th grade curriculum includes SPS in skill-based domain whereas the textbook, and lessons include them in knowledge-based domain.

According to the findings, there exists a discrepancy between the curriculum and textbook regarding the inclusion of SPS depending on the domains. The curriculum includes SPS in the skill-based domain whereas the textbook includes them in the knowledge-based domain. Moreover, this discrepancy is reflected to physics lessons; SPS are aimed in the skill-based domain by skill objectives in the curriculum. However, it is difficult to observe these skills in the classroom. The distribution of SPS in the physics lessons is similar to the distribution of the physics textbook, not the curriculum’s distribution.

Curriculum materials like textbooks, laboratory manuals and workbook and so on are important for the implementation of curriculum. Poor curriculum materials can deprive both students and teachers of ways that let them to comprehend and apply effective teaching practices (Abraham, Grzybowski , Renner & Marek, 1992). Nevertheless, when used accurately, good curriculum materials can be an influential catalyst for improving teaching and learning (Ball & Cohen, 1996; Schmidt, McKnight & Raizen, 1997 as cited in Wang, 1998). Good curriculum materials which are consistent with the curriculum can positively affect students’ learning in the desired way. Actually, some studies have suggested that textbooks that use effective teaching strategies improve student learning and provide good models for teaching (Bishop & Anderson, 1990; Lee, Eichinger, Anderson, Berkheimer & Blakeslee, 1993). Like the 9th grade physics textbook investigated in this study, the curriculum expects textbook writers to provide teaching strategies for teachers to develop SPS of students (Stern & Roseman, 2004). For these reasons, valid identification and validation of curriculum materials that actually support learning in the light of curriculum is essential.

In this study, it is clear that the activities in the textbook are insufficient to develop SPS of students as it is defined in the curriculum. Although the curriculum indicates high level skills like experimenting, the textbook writers designed activities with have highly-structured steps. These activities do not leave room for students to develop experimenting skills; they are stuck with the skills of observing, measuring, predicting, and interpreting data. However, students do not need to design any observing method and measuring tool or method for obtaining data; they are given all steps needed. In brief, the activities in the textbook do net help developing SPS of students aimed in the curriculum. In order to improve student learning in the way that curriculum offers, textbooks should be consistent with the objectives. High quality textbooks can be an important tool for improving learning for students and teachers (Davis & Krajcik, 2005; Roseman, Stern, & Koppal, 2010; Weiss, Pasley, Smith, Banilower & Heck, 2003). In the same way textbooks are vehicles for the goals of curriculum. Therefore, it is important for the textbook to be consistent with the aims of the curriculum and balanced in the domains of SPS.

Conclusion 8: The gap among 9th grade physics curriculum, textbook, and lessons can be caused by ill-defined objectives in the curriculum.

Since education starts with the curriculum, first address is the curriculum itself to understand reasons of gaps determined in this study. The gap between the curriculum, textbook, and lessons can be probably of some objectives defined in the curriculum. Although most of content objectives matched with one science process skill, some of them were not well-defined; are not clear and or feasible. For example, the objective “students will be able to use energy sources efficiently” is too broad and hard to be observed by teachers. Similarly, some objectives are related to daily life applications and they are not feasible in the classroom. However, objectives should use observable verbs; teachers cannot observe whether students realize or not realize. According to some content objectives, it is expected from students to “realize” that is not easy to be observed and evaluated by teachers. In these situations, it is difficult for teachers to make lesson plans for these objectives. Similarly, it is also difficult for writers reflecting these ill-defined content objectives to textbooks.

Conclusion 9: The gap among 9th grade physics curriculum, textbook, and lessons can be caused by the innovation in the curriculum; skill objectives are defined and they are expected to be integrated with content objectives.

9th grade physics curriculum has a different approach in defining the objectives; there are two types of objectives defined in the curriculum that are skill objectives and content objectives. The skill objectives are expected to be integrated with the content objectives which they are matched with. The gap among the curriculum, textbook and lessons can be because of structure of 9th grade physics curriculum; integration of skill objectives with content objectives. This structure is new to textbook writers and teachers; content objectives which are given at knowledge-based level are expected to be harmonized with skill-based level objectives. The curriculum could include more explanations and examples describing how to integrate skill objectives to content ones. It is challenging for teachers achieve goals of a curriculum in which objectives are not clear to teachers and not explained enough the structure of objectives with satisfying examples.

Conclusion 10: The gap between the textbook and physics lessons are less than the gap between the curriculum and textbook and gap between the curriculum and physics lessons in terms of inclusion of SPS.

There is inconsistency among the curriculum, textbook, and lessons in terms of inclusion of SPS. The textbook and lessons seems to be close to each other regarding distribution of SPS whereas this distribution for curriculum is different from the textbook and lessons. The reason behind this gap is probable because of how teachers use textbook. Teachers read textbook more than they read the curriculum. Even these teachers, who took in-service education for this curriculum, are influenced more by textbook than the curriculum. The gap is understandable when the fact of that teachers mostly rely on textbooks is considered (Stern & Roseman, 2004).

Conclusion 11: The gap between the curriculum and physics lessons can be caused by the classroom setting which is so traditional.

The findings show that physics lessons do not include SPS as they are defined in the curriculum. One of the main reasons behind this gap is the classroom setting. Three classrooms observed in this study were traditionally set. It means that students sit two or three together in a desk, and looking toward board. There are two or three lines of desk in the classrooms and two rows between these desks where students and teacher can walk through. That is totally traditional classroom. When the perspective of a curriculum is changed, all elements should be taken into consideration in the light of this change. In this study, the textbook and physics lessons were analyzed in order to reveal the consistency of them with the curriculum regarding SPS. Due to findings, the curriculum aims students discover relations between quantities by experimenting. However, it is difficult to make experiments in a classroom which is traditional. There are researchers having applied experiential learning to classroom-based projects and long term investigations that are student-centered and contextualized (Krajcik et al., 1994; Roup, Gal, Drayton & Pfister, 1993; Schwap, 1976). According to them, students construct their understandings by solving real-world problems in laboratories where they can solve problems and do real science.

Conclusion 12: The gap among 9th grade physics curriculum, textbook and physics lessons of three teachers can be due to nature of SPS.

The gap among the elements investigated in this study can be caused by the nature of SPS since they are interrelated with each other. For example, experimenting includes other skills. In the curriculum, skill of experimenting is included while predicting and inferring are not included openly. However, it actually includes these skills by covering the skill of experimenting. Still there is a gap between the curriculum and the textbook about the inclusion of SPS. Textbook supplies activities in which students can develop the skills of predicting, inferring, observing, measuring, and defining-controlling variables but not experimenting at all.

5.2 Implications

The findings of current study and previous studies confirm that inclusion of SPS in the curriculum, textbook and physics lesson are less than ideal. The results of this study have important implications for curriculum developers, textbook writers and teachers. This section presents some implications due to the findings of the current study. The findings indicate some points that should be taken into account by physics curriculum developers, textbook writers and physics teachers, respectively.

5.2.1 Implications for curriculum developers

Implication 1: Objectives should be clear, feasible, observable, and skill oriented by using content.

When objective is written for content as it is in the 9th grade physics curriculum investigated in this study, and desired to be integrated with more than one skill objectives it is difficult to combine these skills with the content. It is better when they are combined in one objective if possible. Otherwise it becomes too many skill objectives expected to be integrated into content skill.

Implication 2: There should be more explanation about new approach for objectives in the curriculum and more examples for classroom activities meet the objectives especially for the complex ones.

9th grade physics curriculum has a different approach in writing objectives; objectives are defined under two main heading. They are content and skill objectives which are supposed to be attained together. Since this approach is new to all physics teachers in Turkey, the curriculum is better to include more appropriate classroom activities designed for objectives as example for textbook writers and teachers.

Implication 3: Curriculum is better being understood and applied when curriculum developers publish source for classroom activities that teachers can choose the ones they would like to include in their physics lessons.

Teachers who participate in this study are the ones who were trained about this physics curriculum. They also trained other teachers in their schools and or teachers in their city about the implementation this curriculum. Findings show that even these teachers have difficulty in including SPS consistent to the curriculum. According to results, physics lessons of three teachers is closer to textbook rather than the curriculum regarding inclusion of SPS in knowledge-based or skill-based domain. In order to close the gap between the curriculum and physics lessons, curriculum developers should publish a book consisting of classroom activities addressing more than one for each objective. By doing so, teachers have the opportunity to choose the activity which is the most appropriate for their classrooms.

Implication 4: The curriculum should include more objectives addressing the skill of hypothesizing.

Curriculum is weak about including and integrating the skill of hypothesizing in both skill and content objectives. Hypothesizing is one of the most important skills of SPS; experimenting starts with hypothesizing in other words, posing questions and proposing testable solutions. However, the curriculum does not cover this skill as it includes skill of experimenting. Although there are two skill objectives directing hypothesizing, they are not matched with enough numbers of content objectives in order to be reflected into textbook and physics lessons.

5.2.2 Implications for textbook writers

Implication 5: Activities in the textbook should leave more room for students to design and perform their own experiment rather than being highly structured.

This study shows that teachers rely on textbook more than the curriculum that is why textbook has an important role in science education. Moreover, the majority of teachers continue to use the assigned textbook as an essential tool for teaching physics. According to this role, it is important for a curriculum to have appropriate materials in order to be applied in the desired way. The curriculum emphasizes developing students' experimenting skills whereas the textbook cannot go further than developing skills of observing, measuring and predicting. In order to attain the objectives of the curriculum, activities in the textbook could place more emphasis on experimentation, hypothesis-testing without step by step procedure.

Implication 6: Skill of hypothesizing should be covered more in the activities of the textbook.

Activities in the textbook have a similar structure; after given the equipment, procedure is given and then questions are asked to conclude the activity. In the procedure part, students are asked to set the activity. Then, before starting the activity they are asked to predict what will be happen. After making prediction, they conduct the activity; make measurements, observations and also calculations. By the questions in the conclusion part students make inferences. However, in the activities which aim to make students experimenting do not include a step to make hypotheses. Although the step by step procedure is not desired in order to develop SPS of students, it would better if these activities include making hypotheses before generating the activities as a step. Nevertheless, the inquiry-oriented activities have already included skill of hypothesizing. In other words, besides stating that textbook should include inquiry oriented activities, it should include the ones that cover skill of hypothesizing.

5.2.3 Implications for physics teachers

Implication 7: Teachers could use laboratories for physics course at least in order to let students make the activities in the curriculum or and in the textbook.

Traditional classroom setting is not suitable for students to make experiments or activities. It is essential for physics course to make experiments and activities in laboratory. Teachers can create an environment so that students can feel as if they work like scientist in the laboratories. Teachers can choose or design activities that facilitate the development SPS instead of cookbook activities. Since SPS needs activities that students can engage in physics, guided inquiries (Germann, 1989) can be used to help many students make the transition from laboratories in which they work like scientists. The goal is to help students get used to the complications of SPS so that they will be able to engage in independent open scientific experiments as soon as they are able. The highest level of skills is achieved when students have the greatest amount of independence, engaging in activities that come closest to doing real science. Therefore, it is important to use laboratories in which students have opportunity to make experiments in physics course.

5.3 Limitation of the Study

The nature of the skills is a limitation in the current study. Some skills are overlapping each other that make it difficult to distinguish them. In addition, some skills are prerequisite of some others that limit differentiation of skills. For example, observing is needed while making measurement. Predicting is required while a hypothesis is constructed. Moreover, in order to make an inference, one needs to observe. So it is challenging to decide whether to code a text also as observing when it is measuring or code also as predicting when it is hypothesizing or code also as observing when it is inferring.

In this study, this hierarchical structured is taken into account during coding process as; the overlapping skill is coded not the prerequisite, and/or being overlapped skill. The interactions among the skills and the rule of coding limits the results and conclusion of the study.

5.4 Suggestions for Future Research

In this study, eleven SPS are decided to investigate in the 9^{th} grade physics curriculum, textbook, and lessons. They are aimed to examine deeply, however having eleven different is focuses in three different sources limited the depth of the study. So, in order to understand the skills more comprehensively, either number of skills or number of source can be decreased. For example, skills can be handled only in a group: basic science process skills and integrated science process skills. On the other hand, inclusion of skills can be investigated only in textbook deeply. However, in this situation it will be impossible to compare the sources in terms of inclusion of these skills. Therefore, it is more rationale to focus on specified skills in these sources in order to attain deeper view of the representation of skills in them.

Additional research is necessary to demonstrate how students attain goals of the curriculum. By doing so the gap between intended, implemented and attained curriculums will be determined. In the current study only the intended and implemented curriculum were investigated in terms of SPS. However there is a need of study which aims to reveal the SPS level of 9th grade students in physics content.

In this study, only 9th grade level is focused with the curriculum, textbook and physics lessons as the implementation of the curriculum. In order to view the general inclusion of SPS in secondary school, content analysis can be applied to other grade levels; 10, 11 and 12. By doing so, the level of SPS in different levels will be determined. In addition, the findings can be compared and the consistency among the grade levels regarding SPS can be found out. Moreover, the advancement in the SPS accordingly grade levels can be found.

This study showed that even the physics lessons of trained teachers do not fit very well with objectives of the curriculum. More research in physics classrooms is needed to determine the degree of congruence between the curriculum and physics education practice. Since the lack in the literature, more classroom research to reveal any parallels or nonparallel with recent literature findings is necessary. There is a need for research in curriculum especially when there is an important reform with the curriculum materials, instruction and student learning.

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APPENDIX A

SCIENCE PROCESS SKILLS CODE BOOK (SPSCB)

This code book is prepared for qualitative and systematic analyses of the 9th class physics curriculum (TTKB, 2011) in terms of *science process skills*. Code book is composed of four sections; (A) Introduction, (B) Analyze units, (C) Analyze rules, (D) Categories. First section is the introduction, with a brief description of content analysis. In the second section information will be given about and unit of analyses, coding unit and context units are explained. Analyzing rules which should be taken care are defined in third section. Last and fourth section is composed of descriptions of science process skills categories with their examples.

A. Introduction

Content analyze is converting the message, which is demanded to be searched, in quantitative form from a written or illustrated document (Krippendorff, 2004). Berelson (1952), described content analyze as a research technique which makes objective, systematic and quantitative definitions of open content of the communication. The purpose of content analyzes is objective and systematical determination of extent of science process skills involvement in 9th Grade Physics Textbook in our country.

Science Process Skills are defined as "the basic skills which are simplifying the learning in natural sciences, making the students active, improving the taking responsibility feeling for their own learning, increasing the tenacity of the students, teaching to research methods" by Çepni, Ayas, Johnson and Turgut, (1996). It is proved that; students learn science better, getting positive attitude towards science in condition that science process skills take place in a good applied science lecture curriculums (Colvill & Pattie, 2003; Flehinger, 1971; Radford, 1992). Additionally; improving the science process skills enable students solve daily life problems, think critically and make decisions (Temiz, 2001). Considering the results of the researches in science education that prove the positive contributions of science process skills, it is inevitable not to make them a part of the science education.

In this study, science process skills are considered on a preferentially in two categories. One of them is basic science process skills, and the other is integrated science process skills. Basic science process skills are; observing, measuring, inferring, classifying, predicting and scientific communicating. Integrated science process skills are; hypothesizing, experimenting, determining / controlling variables, collecting / interpreting data and modeling skills. Detailed explanations of science process skills are supplied in "Categories" section of this code book.

B. Unit of Analysis

In this content analyze, coding process is carried out by taking coding and context units into consideration. Coding unit is the smallest analysis unit of the communication content, which will be categorized. Context unit is the unit which is limiting the information to be considered in description of recording unit. (Krippendorff, 2004). As used unit types vary depending on properties and content of the analyzed document, they should be described separately for each. Descriptions for coding and context units, which are determined for content analysis of 9th Grade Physics Textbook, are given below in details:

B.1. Context Units

In this codebook, main objectives of 9th Grade Physics Curriculum are taken as context units. As the textbook is prepared according to these objectives and their orders, context units are also arranged respectively.

B.2. Coding Units

Coding unit was described as the smallest analysis unit of the communication content, which will be categorized. Coding units in this study are as below:

1. Paragraph (Should be differentiated from text parts)
2. Sentence or sentences
3. Questions
4. Each step or paragraph of activities (Each of them considered as an individual coding unit).
5. Table with an explanation
6. Picture with an explanation
7. Figure with an explanation
8. Whole context unit

C. Rules of Analysis,

Rules, which should be taken care while making content analysis, are listed below:

1. Before analysis, read and study the code book until understanding categories and description deeply.
2. Before analysis, study 9th Grade Physics Textbook.
3. In order to attain goal of the analysis, take indicated coding units in to consideration in the frame of specified context units.
4. While coding textbook; any context can be chosen as first. However, it is suggested to follow the code book sequence as this will be easier in coding process. Making the coding like this, as if reading the curriculum from beginning to end, not only make coding easier, but also contribute to attain the goal of analysis.
5. In case of getting in difficulty for coding, previous or fallowing parts are checked in the same, previous or following pages within the frame of same context unit.

6. A context unit can involve more than one category, but one coding unit can be matched to only one category.
7. If a code that belongs to one category is repeated in a part, the repeating code is coded only once.
8. If there is no coding for science process skills in a part, that part is coded as NA.

D. Categories

Most Important step of content analysis is the determination of the categories where data will be classified (Simon, 1969). Not having standardized or developed categories suitable for all researches, literature based categories are identified for science process skills in this part. Reliability of a content analysis is dependent on correctness and validity of the category. Consequently, for the reliability of the analysis, it is so important for analyzing person to understand the category deeply.

1. Observing (O)

Observation is a process in order to get direct information for the events and/or things by using any sense organs and/or different devices. (Carin, & Bass, 2001; Buxton, & Provenzo, 2007; Harlen & Qualter 2009). It is data collecting process by using five senses (seeing, smelling, hearing, tasting and feeling) separately or together (Martin, 2006). While making observation; specifications of the things, changes in their movements and structures, changes in the events are taken into considerations. (Buxton, & Provenzo, 2007). An efficient observation is made by careful and systematic way for a specific objective. (Carin, & Bass, 2001). Observations can be qualitative or quantitative. Qualitative observations are the ones that are made directly with sensing organs; such as observing the growth in length of a flower, roughness of the surface, odor of spoiling fruit. Quantitative observations based on data with standard or non-standard units related to things or events (Martin, 2006). For example, indicating the growth in the length of a flower with numerical figures is a quantitative observation.

Observing Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	OKD1 OKD2 OKD3	Express that observing is one of the science process skills Express that scientist makes observations Explains the importance of observing in science or ask question
	Process Knowledge Dimension	OKP1 OKP2 OKP3	Inform about observing skill and ask question Explains how the observation should be and ask question Informs the important points while observing and ask question.
Skill Based Domain	Task Based Skills	OSTP OSTM OSTMP	Makes student observe without a purpose; this is the case that student is physically active but does not think mentally about the purpose of the observation Makes student think about how the observation should be done. Student does not make observation physically, but he/she is mentally active for thinking about observation skill Makes student observe. Ask students to identify changes in objects by using their senses (visual, hearing, smelling, touching and tasting senses) Makes students qualitative observation for a purpose. Request from students to describe physical properties, states, movements and/or changes in these

Example for Category of Observing

Activity / Do gases have volume?

Tools and Devices

Calcium tablet, balloon, test tube, water

Procedure

1. Fill the test tube with some amount of water and put calcium tablet in water.
2. Place the balloon on open side of test tube, as shown in the figure, as soon as possible.

Draw Conclusion:

1. What kind of changes at balloon did you observe after placing the balloon on tube? What can be the reasons for that change?
2. Can you give other examples from daily life similar to this event?
3. Depending on this activity, what can you say about the volume of gasses?

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Explanation for Coding of Observing Skill Activity: At first item of “Draw Conclusion” part, it is requested to make observation for the change as a result of the activity. Student is asked for observing the change in balloon and think about the reason for this change. Consequently, this activity should be coded as OSTMP.

2. Measuring(S)

Measurement is counting and comparing with its simples meaning. It is describing measurable things by means of standard or non-standard units. Measurement process can be made either with standardized devices or non-standardized methods (Wolfinger, 2000). For example, when the dimension of a room is measured by steps of a man, this measurement was made with non-standardized method. When it is measured with a scaled ruler in meters, this measurement was made with standardized “meter” unit. Quality and precision of predictions and explanations can be improved by making measurement (Carin & Bass, 2001; Buxton & Provenzo, 2007).

Measuring Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	SKD1	Express measuring is one of the science process skills.
		SKD2	Express scientists make measurements.
		SKD3	Explains or ask questions about importance of measuring and using measuring devices in science.
		SKD4	Informs about units and their conversions that are used in a measurement.
	Process Knowledge Dimension	SKP1	Informs or asks questions about measuring skill.
		SKP2	Informs or asks questions about process of measuring.
		SKP3	Informs or asks questions about the aspects to take care while measuring.
Skill Based Domain	Task Based Skills	SSTP	Makes student measure and/or use measurement tool; this is the case that student is physically active but does not think mentally about the measurement.
		SSTM	Makes student think about how measuring should be done. Student does not make measurement physically, but he/she is mentally active about thinking about measuring skill.
		SSTMP	Makes student measure and/or develop measurement tool. Ask students to make quantitative identifications. Difference between SSTMP and SSTP; student is not only physically but also mentally active in SSTMP.

Example for Category of Measuring

Activity / Measuring Same Temperature in Thermometers Having Different with Materials

Tools and Devices

Thermometer with mercury, thermometer with alcohol, Beaker, Spirit Stoves, Tripod, Water

Procedure

1. Prepare a set up that is shown in the figure.
2. Draw a similar table as below on your notebooks. Record data of thermometers with defined intervals till water starts to boil, into the relevant space at the table.

Measurements	Thermometer with Alcohol	Thermometer with mercury
Measurement 1		
Measurement 2		

(Sample table)

Draw Conclusion

1. Is there any difference between measurements made with thermometers having alcohol and mercury?
2. After which temperature it started to be different?
3. Which thermometer showed correct values?
4. What was the last value that you could measure with thermometer having alcohol?

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Explanation for Coding of Measuring Skill Activity: At second item of “Procedure” part, it is requested to make measurement with two different types of thermometers and record data of them. Student is asked for recording quantitative data in second item’s coding unit. Consequently, this activity should be coded as SSTMP.

3. Inferring (I)

Inference is making the best guess about the reason of a happening (Martin, 2006). Inference requires interpretation of the events with past experience and knowledge (Carin & Bass, 2001; Buxton & Provenzo, 2007). Important point for this subject is; to distinguish the difference between inference and guessing ability. Guessing is forecasting the result of an event which has not been occurred. However, inference is commenting on the reasons of an already occurred event. For making a correct and efficacious inference, good observation and data collection procedures should be done. In this context, it is important to emphasis the relationship between inference and observation skills.

Inferring Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	IKD1 IKD2 IKD3	Express inferring is one of the science process skills. Express scientists make interference. Explains or ask questions about importance of inferring.
	Process Knowledge Dimension	IKP1 IKP2 IKP3	Informs or asks questions about inferring skill. Informs or asks questions about process of inferring. Informs or asks questions about the aspects to take care while inferring.
Skill Based Domain	Task Based Skills	ISTP ISTM ISTMP	Makes student infer without any requirement of mental activity. This code can be used for parts in textbook where the explanation is given just after the part that ask student for make inference. Makes student think about interferences made by other people. Student does not make measurement himself/herself. But he/she is mentally active about thinking about making interference skill. Makes student explain about reason(s) of an event. Ask students to make discussion about possible reasons of an event depending on data.

Example for Category of Inferring

Activity / Observation of Wave

Tools and Devices

Wave basin, three pieces cork, necessary amount of water, light source, rheostat, and power source.

Procedure

1. Make groups of five or six people and assign duties by taking the fallowing activity steps into consideration.
2. Place a light source on the setup that you prepared for this activity.
3. Vibrate first cork with your hand and observe changes, apparition at the bottom of wave basin by the help of light source.

Draw Conclusion

1. Do corks start to vibrate when the vibration reach to them according to view produced by light that shows changes in wave basin?
2. After a while, although corks vibrate up and down in a sequence, they do not leave their positions. What does it mean to you?
3. How can you explain the existence of created wave at the other locations of wave basin?

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Explanation for Coding of Inferring Skill Activity: At third item of “Draw Conclusion” part, it is requested to make interference for an occurred vibration event, by asking why waves are observed at other locations of wave basin. So, the third item’s coding unit should be coded as ISTM.

4. Classifying (L)

Classification, which is grouping the objects and/or events according to their similar or different specifications, is an important way of organizing the information (Wolfinger, 2000). Classification is made depending on knowledge and/or the data which were obtained by observations. It should be careful about having a clear classification parameter, to avoid any confusion during classifying. Because of this reason, classification parameter should be objective. For example, classifications of cinema films in terms of their types is much better method than classifying them by saying boring or funny (Settlage & Southerland, 2007).

Classifying Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	LKD1	Express classifying is one of the science process skills.
		LKD2	Express scientists make classifications in their studies.
		LKD3	Explains or ask questions about importance of classifying.
		LKD4	Informs about classifying; its criteria, and/or common and/or different specifications that is made before.
	Process Knowledge Dimension	LKP1	Informs or asks questions about classifying skill.
		LKP2	Informs or asks questions about process of classification.
		LKP3	Informs or asks questions about the aspects to take care while classifying.
Skill Based Domain	Task Based Skills	LSTM1	Asks to determine common properties of objects or events. Asks to determine different properties of objects or events. Asks to put in order events or objects according to their relationship.
		LSTM2	Asks to classify depending on supplied data. Asks to identify, express, discuss similar properties of known classification groups. Asks to identify, express, discuss differential properties of known classification groups. Informs, ask question or make think about specified parameter in a known classification.
	Transferring Skill	LSRM	Asks from students to classify objects or event according the parameter(s) that they specified by themselves.

Example for Category of Classifying Skill:

> …When you observe circulation in nature carefully, you can detect solid, liquid and gas forms of water in different stages of this cycle. Water is gas form while evaporating, liquid form while raining, solid form while snowing or hailing.
>
> During science and technology lectures, we described matter as an object that has mass, volume and passivity. We learned that our world is composed of water which we drink, air that we breath and soil on which we walk and many other matters.
>
> Have you ever thought that matters in the world have similar and different properties?
>
> It is supposed that you have already observed that small droplets are sometimes in water, sometimes in vapor and sometimes in hail form during water cycle. May it be possible to describe common properties for all of these three phases of this droplet?
>
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Explanation for Coding of Classifying Skill Activity: In this paragraph section which is taken from a main text; after informing about classification of matter according to its forms (solid, liquid, and gas), common properties of three different forms of matter are asked for it. So, coding unit of this sentence in the paragraph should be coded as LSTM2.

5. Predicting (P)

Predicting is foreseeing the possible result of an unrealized event depending on the past experiences and collected data (Buxton & Provenzo, 2007). Differential property of predicting compared to inferring is; predicting is related to the future events which are not occurred yet. However, while inferring; it is stated on the reasons of an already occurred event (Carin & Bass, 2001). Scientific research is, a continuously prediction making and proving or disposing of an argument process. Predictions can be correct, wrong or deficient. Events may results in as predicted or not. Important point is to learn if the prediction is correct, wrong or deficient by testing it (Martin, 2006; Wolfinger, 2000).

Predicting Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	PKD1	Express predicting is one of the science process skills.
		PKD2	Express scientists make predictions about objects or events in their studies.
		PKD3	Explains or ask questions about importance of predicting.
	Process Knowledge Dimension	PKP1	Informs or asks questions about predicting skill.
		PKP2	Informs or asks questions about process of predicting depending on data.
		PKP3	Informs or asks questions about the aspects to take care while predicting.
Skill Based Domain	Task Based Skills	PSTM1	Makes student think about what can be predicted depending on observations and collected data.
		PSTM2	Asks student to predict about possible results of a future event, activity or experience.
		PSTM3	Asks student to predict about possible effects of a new variable by using relationship of known variables.

Example for Category of Predicting Skill:

Activity / Observing Water Flow

Tools and Devices

2 pieces empty detergent pack, rubber hose (15-20cm), and colored water

Procedure

1. Make groups of five or six people and assign duties by taking the fallowing activity steps into consideration.
2. Prepare a set up that is shown in the figure.
3. Predict if there will be water flow when the taps opens; first for same amount of water and then for different amount of water in the packs.
4. Observe if there will be water flow by opening the tabs.

Draw Conclusion

1. Is there any difference between you prediction and observation?
2. In which case there had been a water flow and until when it had continued?
3. From which pack to which pack did the water flow occurred?

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Explanation for Coding of Predicting Skill Activity: In this activity, after preparing the activity setup, it is requested to make a prediction about the result of activity before starting the process. Before opening the tabs, it is expected that a prediction will be made if there will be water flow or not when tabs are opened. At the fallowing step, in order to check if the prediction is correct, wrong or deficient; tabs are opened and results are compared with the predictions. In that case, third item (coding unit) of “Procedure” part should be coded as PSTM1.

6. Scientific Communication (C)

Communication is transmitting and sharing idea and/or comments with others, in verbal or written formats (Martin, 2006; Wolfinger, 2000). Scientific communication is, sharing and making discussions about the whole or a part of a scientific research. Symbolic representations such as; words, tables, graphs, models can be used for scientific communication. Sharing, judging and analyzing of scientific researchers are very important not only for improvement of the science, but also for repeatability of the researches (Buxton, & Provenzo, 2007).

Scientific Communication Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	CKD1	Express scientific communication is one of the science process skills.
		CKD2	Express scientists share data obtained from experiments and observations to be checked, confirmed, and repeated by other scientists.
		CKD3	Emphasize and think about the necessity of sharing, discussing and criticizing / analyzing data for improvement of science. Emphasize the effect of communication on construction or distribution of scientific knowledge.
	Process Knowledge Dimension	CKP1	Informs or asks questions about scientific communication skill.
		CKP2	Informs or asks questions about process of scientific communication.
		CKP3	Informs or asks questions about the aspects to take care during scientific communication.
Skill Based Domain	Task Based Skills	CSTP	Asks to share researches, which are done from written sources, with others. Student does not make any contribution, search for existing knowledge and share findings.
		CSTM	Make student think about scientific communication. Student does not make any presentation and/or discuss with others physically, but only thinks how to do it well.
		CSTMP	Asks to share observations, obtained data, interferences and/or predictions, hypothesis, control procedure of variables, design of experiments, results of experiments, and result of studies, ideas and/or comments. Makes presentation about a scientific research, experiment, observation. Prepares report for a scientific research, experiment, observation.

Example for Category of Scientific Communication Skill

Let's Investigate
Generally functions of devices that are used in daily life such as; electrical heaters, adjustable table lambs, can be controlled by a single switch. Investigate the working principle of this switch and try to figure out which circuit element that you learned up to now, it can be matched. During your research, you can utilize from electrical and physics engineers; electronic devices service people, internet and scientific articles written about this subject. Prepare an open diagram of the investigated device depending on obtained data and share this with your friends.
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Explanation for Coding of Scientific Communication Skill Activity: At this "Let's Investigate" part of the textbook, students are requested to make a research about working principle of switches of electrical devices and draw the diagram of investigated device depending on obtained data from their research. Additionally, it is requested to transfer obtained data from student to other students by sharing research and drawn diagram. Because of that, paragraph coding unit at "Let's Investigate" part should be coded as CSTMP.

7. Hypothesing (H)

Hypothesize testable proposals that are aiming to show the relationship between variables depending on experience, observation and idea (Martin, 2006). Hypothesis can be made either for a problem or for some events and properties, even for discovering the relationship between variables. Hypothesize is a kind of prediction that proposing how will be the effect of independent variable on dependent variable, however prediction is related to only the result of unrealized event (Bailer, Raming, Ramsey, 1995). Hypothesize guides researchers to the variables that they need to concentrate on, as it identifies the center point of a research. While hypothesizing important point is to be testable rather than to be correct. After hypothesizing, hypothesis should be tested for its correctness with different methods (Raming & Ramsey, 2006).

Hypothesing Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	HKD1	Express hypothesing is one of the science process skills.
		HKD2	Express scientists hypothesize in their studies, give part for hypothesis.
		HKD3	Explains or ask questions about importance of hypothesing.
	Process Knowledge Dimension	HKP1	Explains what is hypothesis and/or how to hypothesis or asks questions.
		HKP2	Informs or asks questions about process of hypothesing, and properties of a good hypothesis (to be rational, clear and functional, testable).
		HKP3	Informs or asks questions about the aspects to take care during hypothesing.
Skill Based Domain	Task Based Skills	HSTM1	Asks to evaluate supplied or created hypothesis in terms of properties that a good hypothesis should have.
		HSTM2	Asks to decide if a hypothesis can be tested or not. Asks to make a testable hypothesis for a research or an experiment to explain an event or relationship.

Example for Category of Hypothesing Skill:

…The most significant difference between scientific and other researches is that; scientific researches depend on data. First of all, a scientific research needs a problem to be investigated. After determination of the problem; necessary observations, experiments, researches are made in order to obtain data for explanation of the problem. Having obtained data, some hypotheses are made. Do you know what hypothesis is?

Hypothesis, which is made depending on data, is a temporary solution method of a scientific problem. A scientific hypothesis should be able solve the problem within some limitations and involve all existing data. Additionally, validity of a scientific hypothesis should be testable by the help of some experiments. After that, correctness and validity of predictions based on hypothesis, consequently the hypothesis, are tested by making controlled experiments. This process is done by comparing test results with predictions. Finally, it is concluded if obtained data from those controlled experiments are supporting the hypothesis or not. In case of necessity, degree of support is also decided.

Scientists continuously collect data during their researches and make some statements depending on those data. In order to solve a research problem, scientists hypothesize based on data. These hypothesizes are exposed to a continuous testing process. During this testing process, some of them strongly supported with experiments and become more important, on the other hand it is concluded that some of them are not valid.

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Explanation for Coding of Hypothesing Skill Activity: In this text, coding units of second and third paragraph, scientific method, hypothesing skill are explained and it is expressed that scientists continuously make hypothesing and test those hypothesizes. So, correct coding unit should be HKP1 for second paragraph and HKD2 for third paragraph.

8. Defining and Controlling Variables (V):

Defining variables is enouncing all effecting factors for an experiment which will be done. Control of variables is; not only defining variables which will be changed and/or stabilized, but also changing only independence variable, which will be tested, by stabilizing all other variables excluding independence (Arthur, 1993). Only one variable is changed in an experiment, in order to find the affecting variable on the test result (Peters, & Stout, 2006). Thus, influence of the independent variable on dependent variable can be explained in an experiment.

Defining and Controlling Variables Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	VKD1	Express defining and/or controlling variables are one of the science process skills.
		VKD2	Explains that one, some or all of the below aspects are involved in the experiments carried out by scientists: Defining and identification of variables, procedure of controlling variables during the experiment, Making decision of changing variables and how to make such decisions, Procedure of making a conclusion at the end of an experiment depending on obtained data.
		VKD3	Explains or ask questions about importance of defining and controlling variables in science.
	Process Knowledge Dimension	VKP1	Informs or asks questions about defining and controlling variables.
		VKP2	Informs or asks questions about process of defining and controlling variables.
		VKP3	Informs or asks questions about the aspects to take care during defining and controlling variables.
Skill Based Domain	Task Based Skills	VSTP	Explains how the variables will be controlled and ask student to make it. This is the case in which student is physically active but not mentally, as the method of controlling variables is already explained.
		VSTM1	Ask student to define dependent, independent and controlled variables for a case, event or experiment. Student is not physically, but mentally active as he/she is thinking about defining and controlling variables.
		VSTM2	Ask students to define and/or identify variables for a case, event or experiment. Also to think how to control variables of an experiment. Student is not physically, but mentally active as he/she is thinking about controlling variables.
		VSTMP	Makes students do at least one, some or all of these activities for a case, event or experiment: Defining variables, Defining dependent variables, Defining independent variables, Defining controlled variables, Defining un-controlled variables, Defining changing procedure of independent variables, Expressing relationship of two variables after an experiment, Investigating the reason of an unexpected result, based on variables when it occurs.

Example for Category of Defining and Controlling Variables Skill:

> Problem Solving
>
> Salih Can and his father go for fishing at weekend by boat. They cast fishing lines into sea and start to wait. Meanwhile wind is blowing slowly. During Salih Can fishing, he also observes waves. He recognizes decrease in number of waves and distance between each wave. He asks the reason of this case.
>
> What can be the reason of change in speed and length of waves when they get closer to coast, according to you?
> Do you think most effective factor for this problem is depth or wave speed?
> Determination of Variables:
> Dependent variables: ……………………………………………………………………...
> Independent variables: …………………………………………………………...………..
> Controlled variables: ………………………………………...………………………..
> Measurement tools: ……………………………………………….………………….
>
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Explanation for Coding of Defining and Controlling Variables Skill Activity: In this "Problem Solving" part of textbook, an explanation is requested for a due diligence. Reason of decrease in distance between waves is asked. In other words, it is requested to determine dependent variables causing this case. Second question make students think about two different variables. Then students are asked to determine dependent, independent and controlled variables. In this part question sentence, which is the coding unit, should be coded as VSTM.

9. Experimenting (E)

Making experiment is a complex skill that involves all other skills. Basic purpose of experimenting is the test the hypothesis or predictions, in such a way that making an effective plan to detect the effect of a selected independent variable on the dependent variable (Martin, 2006). Experimenting skill involves the skills of; choosing suitable tools and devices for prediction or hypothesis, correct utilizing of those tools and devices, building up suitable setup according to the purpose of the experiment, obtaining data by controlling variables, evaluating the prediction or hypothesis by reaching to a rational conclusion (Settlage & Southerland, 2007). As skill of experimenting involves all other skills it may be difficult to differentiate this skill. Therefore both of below aspects should be checked:

- Predicting the result of the experiment or making hypothesis for explaining the relationship between two variables before starting to the experiment.

- Testing the prediction or hypothesis.

Experimenting Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	EKD1 EKD2 EKD3	Express experimenting is one of the science process skills. Express scientists design and make experiment. Explains or ask questions about importance of experimenting.
	Process Knowledge Dimension	EKP1 EKP2 EKP3	Informs or asks questions about experimenting skill. Informs or asks questions about process of designing and/or making experiment and how to use experiment devices. Informs or asks questions about the aspects to take care during experimenting.
Skill Based Domain	Task Based Skills	ESTP ESTM ESTMP	Ask students to make experiment, of which steps are designated, involving all below tasks: • Ask students to predict result of experiment or hypostasize. • Ask students to prepare setup of experiment. • Ask students to collect data. • Ask students to interfere data. • Ask students to decide on correctness of prediction or hypothesis depending on obtained data from experiment. Does not ask students to make experiment physically. However, Make them think about how to make a set up for an experiment to test hypothesis. Ask student to choose appropriate tools and devices for an experiment to be done. Request from students to prepare a genuine experiment setup for one of the following purposes; test a hypothesis, asses a prediction, identify relationship between variables or answer a question.

Example for Category of Experimenting Skill Activity:

Activity- Let's Make a Distinction between Heat and Temperature

! Be careful while using spirit stove in the activity.

Equipment
2 thermometers, 2 beakers, 2 spirit stoves, Water (1.5 L), 2 tripods

Procedure
1. As shown in the photograph build the set up carefully by putting water into the beakers as one of them has water twice as much as the other.
2. Measure the temperature of the water in each beaker.
3. By discussing, make a prediction about the values indicated by the thermometers will be the same or not if heat is given to each of the beakers for equal periods of time.
4. Light the spirit stoves carefully.
5. By observing the values indicated by the thermometers at regular intervals, fill in the table similar to the following to your notebooks.

Time	t=0	t	2t	3t	4t
Temperature of lesser water					
Temperature of greater water					
Total heat given					

Draw Conclusion
1. Is there a difference between your prediction and observation? If there is, what is the reason of this difference in your opinion?
2. What is the reason of the difference between the temperature changes of the substances in the table although the same amount of heat is given?

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Explanation for Coding of Experimenting Skill Activity: In this activity, firstly students are asked to make a prediction for the result of experiment (Procedure, item 3). They are expected to collect data and record these data by executing experiment steps (Procedure, item 5). Test their predictions with the help of collected data. In this case, being a coding unit as well as whole activity should be coded as ESTP.

10. Collecting and Interpreting Data (D)

Collecting data skill is gathering qualitative and/or quantitative data depending on prediction and hypothesis and transforming the data into different forms such as table, graph, and chart. Interpretation skill is the ability to determine the relationship between dependent and independent variables by inferring the data in a logical way (Ramign, & Ramsey, 2006; Martin, 2006; Wolfinger, 2000). Three important aspects are; (a) data should be collected according to the purpose, (b) data should be organized in most suitable format for reaching in a valid conclusion and (c) thinking on the data to conclude with logical result.

Collecting and Interpreting Data Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	DKD1	Express collecting, sorting in a systematic manner, cleaning data from irrelevant ones and/or interpreting data are one of the science process skills.
		DKD2	Express scientists systematically collect data, organize them and/or make logical interpretations. Gives detailed example for collecting data and interpretation studies *(Gives examples not only with general phrases such as "collected those data", but also including detailed information about how data are collected, how they are organized, what kind of aspects are taken care during that process).*
		DKD3	Explains or ask questions about importance of collecting and interpreting data
	Process Knowledge Dimension	DKP1	Informs or asks questions about collecting and interpreting data skill.
		DKP2	Informs or asks questions about process of collecting and/or interpreting data. Gives examples about how data of a study is organized.
		DKP3	Informs or asks questions about the aspects to take care during collecting and interpreting data.
Skill Based Domain	Task Based Skills	DSTP	Ask students to collect data: Requests from students to record obtained data from their observations, Ask students to collect data from trials made with variables.
		DSTM	Ask students to organize collected data: Requests to clean data from the unnecessary ones that are not effective and/or can cause complication. Inquire to convert from one form (text, graphic, tables, pie-chart etc.) to another form (text, graphic, tables, pie-chart etc.).
	Transferable Skills	DSR1	Asks students to make interpret data. Requests from students to use visual forms (graphs, tables, pie-charts etc.). Inquire interpret a visual form (graphs, tables, pie-charts etc.). Asks students to compare predictions with results depending on data obtained from observation/ experiment.
		DSR2	Asks students to draw a conclusion by interpreting data. Asks students to make prediction about general applicability of obtained data.

Example for Category of Collecting and Interpreting Data Skill

Problem Solving

Problem Case

In Uğurlu town, some of the students are curious about the magnitude of velocity of train passing in this town. What kind of method can these students use to find magnitude of speed of the train? (If there is no train in your location, prefer most suitable transportation vehicle for you.)

Procedure

First of all, let's find a linear part of train rail that train passes. Locate five students, parallel to rails and at a distance safe enough, with fifty meters gap between each of them. Note that they all have chronometer with them. Students should start chronometer when train, locomotive as reference point, passes first student line and stop when train arrive to his/her line. Let's draw a table as shown below, fill it with measured durations by the help of chronometer, and sketch the distance – time graph depending on the data on table.

Distance (m)	0	50	100	150	200
Time (s)	0				

While drawing distance – time graph, it is necessary to ignore mistakes caused by time measurements.

Draw conclusion

1. How can students determine magnitude of velocity of the train by using their data? Write and calculate in details.
2. What kind of other moving objects' magnitude of velocity can you determine by using similar method?
3. What can be other methods to calculate magnitude of velocity of the train? Please write.

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Explanation for Coding of Collecting and Interpreting Data Skill Activity: In this "Problem Solving" part of the textbook, first of all students are asked to fill the collected data, which is collected during observation by the help of an example table, in appropriate spaces of a table (DSTP). After that, students are requested to transfer these data into another form that is a graph (DSTM). At "Draw Conclusion" part, it is demanded from students to express their opinions about how to calculate magnitude of velocity of a variable by utilizing sketched graph (DSR2). In this case this part of the textbook should be coded as DSTP, DSTM and DSR2 respectively.

11. Modeling (M)

Model, is understandable, concrete and visual format of a concept, event, fact or system, which are not normally can be detected by five sense organs. Any object, drawing, mathematical equivalence, computer program or similar things can be models. Value of the model is its specification that explains how something works (Wolfinger, 2000; Martin, 2006).

Modeling Codes

	Type	Code	Description
Knowledge Based Domain	Declarative Knowledge Dimension	MKD1 MKD2 MKD3	Express modeling is one of the science process skills. Express scientists make models to make concepts objects and events more understandable which are difficult to be understood. Informs in detail about models that scientists did. (Who constructed the model, similarities and differences between model and reference) Explains or ask questions about importance of modeling in science.
	Process Knowledge Dimension	MKP1 MKP2 MKP3	Informs about modeling skill. Emphasis or asks questions about similarities and differences between model and reference object /event. Informs or asks questions about process of modeling. Use models to explain events, objects or idea by confirming below conditions: • Emphasis it is the model of a narrative thing. • Informs about similarities and differences between the reference Informs about the aspects to take care during modeling Informs or asks questions about the importance of collecting data of reference as much as possible to be able to make modeling.
Skill Based Domain	Task Based Skills	MSTP MSTM MSTMP	Asks student to make previously constructed model. Asks student to find similarities and/or differences between model and reference (object, event concept system etc.). Asks students to explain relationship between events and concepts by using previously made models. Asks students to convert a form (i.e.; three dimensional objects) into another form (i.e. two dimensional drawing) in such a way that it will represent or explain the reference. Asks students to make original model of a new concept or event.

Example for Category of Modeling

Activity / Make Modeling

Tools and Devices
One piece of closed box, measure, calculator, graph paper

Procedure
1. Make groups of five or six people and assign duties by taking the fallowing activity steps into consideration.
2. Try to collect some data about the inside shape of the given box together with your group members.
3. By using collected data, draw a model for internal shape of the box that can explain it best.
4. Discuss with your group members about relationship of this model with your data.

Draw Conclusion
1. Compare your model with model of other groups.
2. Can you say which model is the best? Why?
3. Are there any similarities between your and scientist's modeling process?

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Explanation for Coding of Modeling Skill Activity: In this activity, students are asked to collect data and draw a best representative model of internal shape for three dimensional box (Procedure, Item 2 & item 3). Moreover students are requested to compare all models and choose the best drawn model (Draw Conclusion, item 1 & item 2). At the last item of activity, it is demanded from students to compare their process with model construction process of scientists (Draw Conclusion, item 3). In this case, item 2 and item 3 (coding units) at "Procedure" part should be coded as MSTMP.

APPENDIX B

BİLİMSEL SÜREÇ BECERİLERİ KOD REHBERİ

Bu kod rehberi, Ortaöğretim 9. Sınıf Fizik Dersi Kitabının (Kalyoncu ve ark., 2010) nesnel ve sistematik bir şekilde *bilimsel süreç becerileri* (BSB) açısından incelenmesi için hazırlanmıştır. Kod rehberi, (1) Giriş, (2) Analiz birimleri, (3) Kategoriler, (4) Analiz kuralları olmak üzere dört bölümden oluşmaktadır. Birinci bölüm, içerik analizi hakkında kısa ve öz bir açıklamadan oluşan giriş bölümüdür. İkinci bölümde analiz birimleri hakkında bilgi verilip, çalışmanın bağlam ve kayıt birimleri açıklanmıştır. Üçüncü bölümde bilimsel süreç becerilerine ait kategorilerin tanımları örnekleriyle açıklanmıştır. Son bölüm olan dördüncü bölümde ise dikkat edilmesi gereken analiz kurallarına yer verilmiştir.

A. Giriş

İçerik analizi, yazılı ya da resimli bir belgeden araştırmacının incelemek istediği mesajın nicelleştirilmesidir (Krippendorff, 2004). Berelson (1952), ise içerik analizini iletişimin açık içeriğinin nesnel, sistematik ve nicel tanımlarını yapan bir araştırma tekniği olarak tanımlamıştır. Bu çalışmada yapılan içerik analizinin amacı, ülkemizde Ortaöğretim 9. Sınıflar için Talim terbiye Kurulundan onay almış Fizik Ders Kitabında (Kalyoncu ve ark., 2010) bilimsel süreç becerilerine ne kadar yer verildiğini nesnel ve sistematik bir şekilde ortaya çıkarmaktır.

Günümüzde fen bilimleri eğitimi; fen bilgisi yanında, bilimsel düşünme ve süreç becerilerini geliştirmeye yönelik hedeflere vurgu yapmaktadır. Bu yaklaşım öğretim programları başta olmak üzere ders kitaplarını da kapsayan tüm öğretimsel süreçlere yansımaktadır. Bu yaklaşımla geliştirilen ders kitapları, çeşitli etkinlik, uygulama ve sorularla öğrencilerde a) bilimsel süreç becerileri, b) eleştirel düşünme becerileri, c) bilimsel muhakeme becerileri olmak üzere üç yönlü düşünme becerisini geliştirecek şekilde tasarlanmıştır. (Dökme, 2004).

Bu düşünme becerilerinden *Bilimsel Süreç Becerileri*, Çepni, Ayas, Johnson ve Turgut, (1996) tarafından "fen bilimlerinde öğrenmeyi kolaylaştıran, öğrencilerin aktif olmasını sağlayan, kendi öğrenmelerinde sorumluluk alma duygusunu geliştiren, öğrenmenin kalıcılığını arttıran, araştırma yolları ve yöntemlerini gösteren temel beceriler" olarak tanımlanmıştır. İyi bir fen müfredatında bilimsel süreç becerilerine yer verildiği takdirde öğrencilerin fen konularını daha iyi öğrendiği, fen dersine olan tutumlarının pozitif yönde değiştiği ve fen dersi ortaya konmuştur (Colvill & Pattie, 2003; Flehinger, 1971; Radford, 1992). Ayrıca bilimsel süreç becerilerinin geliştirilmesi öğrencilere problem çözme, eleştirel düşünme, karar verme, günlük hayatta karşılaştıkları sorunları belirleme, çözüm önerileri sunma ve meraklarını giderme imkânları verir (Temiz, 2001). Bilimsel süreç becerilerinin fen eğitimine katkılarını gösteren çalışmalar dikkate alındığında, bu becerileri fen öğretiminin bir parçası haline getirmek kaçınılmazdır.

Bu çalışmada bilimsel süreç becerileri, temel bilimsel süreç becerileri ve bütünleşik bilimsel süreç becerileri olarak iki boyutta ele alınmaktadır. Temel bilimsel süreç becerileri; gözlem yapma, ölçme, çıkarım yapma, sınıflandırma, tahmin etme ve bilimsel iletişim kurma becerilerinden oluşurken, bütünleşik bilimsel süreç becerileri ise; hipotez kurma, deney tasarlama/yapma, değişkenleri belirleme/kontrol etme, veri toplama/yorumlama ve model yapma becerileridir. Bilimsel süreç becerilerinin detaylı tanımlarına kod rehberinde Kategoriler Bölümünde yer verilmiştir.

B. Analiz Birimleri

Bu içerik analizinde kodlama işlemi, kayıt birimi ve bağlam birimi dikkate alınarak yapılır. Kayıt birimi, "iletişim içeriğinin belli bir kategoriye yerleştirilecek olan en küçük çözümleme birimidir. Bağlam birimi ise, kayıt birimini değerlendirmek için, içinde yer aldığı bağlamı sınırlandıran en geniş bölümdür (Tavşancıl, & Aslan, 2001). Kullanılan birim türleri analiz edilen belgenin niteliğine ve içeriğine göre değişiklik gösterdiğinden dolayı incelenecek her belge için ayrı ayrı tanımlanmalıdır. Ortaöğretim 9. Sınıf Fizik Dersi Kitabı içerik analizi için belirlenen bağlam ve kayıt birimleri aşağıda detayları ile tanımlanmıştır. Bağlam ve kayıt birimlerine ek olarak bu çalışmada Ortaöğretim 9. Sınıf Fizik Dersi Kitabı'nda yer alan birbirinden farklı bölümler de analiz birimi olarak dikkate alınır. Bağlam birimi, kayıt birimini doğru ve tutarlı bir şekilde kodlamak için belirlenirken ve hiçbir şekilde kodlanmazken, kitabın bölümleri bilimsel süreç becerileri kodlarından bağımsız bir şekilde kodlanır.

B.1. Bağlam Birimleri

Bu çalışmada, 9. Sınıf Fizik Dersi Öğretim Programında yer alan üst kazanımlar bağlam birimi olarak alınmıştır. Kitap bu kazanımlara ve sırasına göre hazırlandığı için bağlam birimleri de bu sıralamaya uygun olacak şekilde belirlenmiştir. Analiz sırasında dikkate alınacak bağlam birimleri her ünite için aşağıdaki şekilde belirlenmiştir:

Ünite 1

1.1. Fiziğin uğraş alanı: 20. sayfadan 22. sayfadaki "Naz'ın Gözlemi" başlığa kadar.

1.2. Fiziğin doğası: sayfa 22'deki "Naz'ın Gözlemi" başlığından 41. sayfadaki "Ayşe Nine Ne Yapmalı" başlığına kadar.

1.3. Fizikte modelleme ve matematiğin yeri: 41. sayfadaki "Ayşe Nine Ne Yapmalı"dan 43. sayfadaki "Nereden Nereye" başlığına kadar.

1.4. Fizik, günlük yaşam ve teknoloji: 43. sayfadaki "Nereden Nereye" başlığından 45. sayfanın sonuna kadar.

Ünite 2

2.1. İş, güç ve enerji: 52. Sayfanın başından 60. Sayfadaki 3. Etkinlik; "Enerji Dönüşümü"ne kadar.

2.2. Enerji dönüşümleri ve enerjinin korunumu: 60. Sayfadaki 3. Etkinlik; "Enerji Dönüşümü"nden 69. Sayfadaki "Hayat Kaynağı Nereden Karşılanmakta?" başlığına kadar.

2.3. Enerji kaynakları: 69. Sayfadaki "Hayat Kaynağı Nereden Karşılanmakta?" başlığından 75. Sayfanın sonuna kadar.

2.4. Isı ve sıcaklık: 76. Sayfanın başından 82. Sayfanın sonuna kadar.

Ünite 3

3.1. Maddelerin sınıflandırılması ve özellikleri: 92. Sayfadan 111. Sayfadaki "Her Değişim Zararlı mıdır?" başlığına kadar.

3.2. Maddelerin değişimi: 111. Sayfadaki "Her Değişim Zararlı mıdır?" başlığından 116. Sayfanın sonuna kadar.

Ünite 4

4.1. Bir boyutta hareket:126. Sayfanın başından 144. Sayfanın sonuna kadar.

4.2. Doğadaki temel kuvvetler: 145. Sayfanın başından 148. Sayfanın sonuna kadar.

4.3. Newton'un Hareket Yasaları: 149. Sayfanın sonundan 156. Sayfanın sonuna kadar.

4.4. Sürtünme Kuvveti:157. Sayfanın başından 165. Sayfanın sonuna kadar.

Ünite 5

5.1. Elektrik Akımı: 178. Sayfanın başından 198. Sayfanın sonuna kadar.

5.2. Elektrik akımının manyetik etkisi: 199. Sayfanın başından 205. Sayfanın sonuna kadar.

Ünite 6

6.1. Dalgalara ait temel büyüklükler: 214. Sayfanın başından 239. Sayfanın sonuna kadar.

B.2. Kayıt Birimleri

Kayıt birimi, içeriğin belli bir kategoriye yerleştirilecek olan en küçük çözümleme birimi olarak ifade edilmişti. Bu çalışmada belirlenen kayıt birimleri şöyledir;

1. Paragraf (Kitap bölümü olan Paragraf ile karıştırılmamalı)
2. Cümle ya da cümleler
3. Sorular

4. Etkinliklerin her bir maddesi (basamağı) ya da paragrafı (her biri ayrı bir kayıt birimi olarak değerlendirilir.)

5. Açıklaması olan tablo

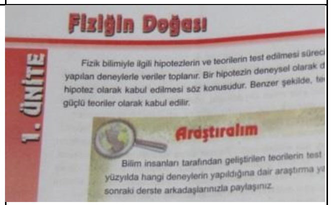
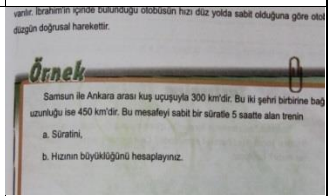
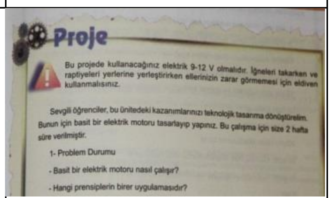
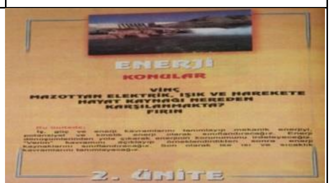
6. Açıklaması olan resim

7. Açıklaması olan şekil

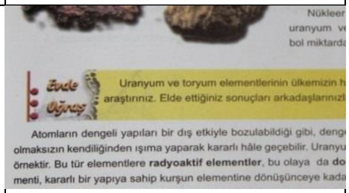
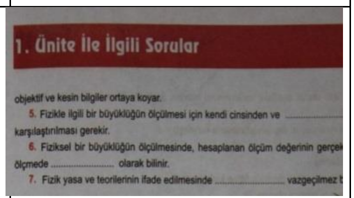
8. Bağlam biriminin tamamı

B.3. Kitabın Bölümleri

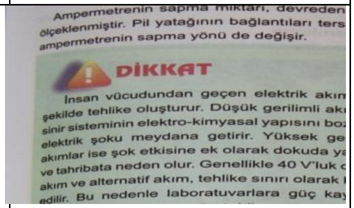
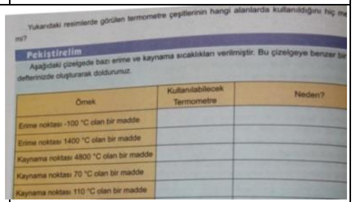
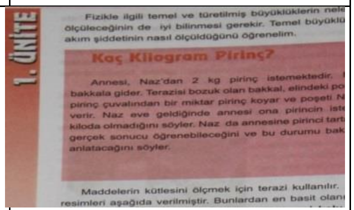
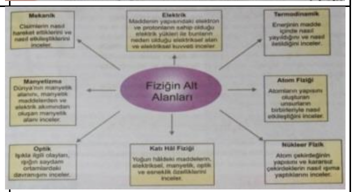
Tablo1. Kitap Bölümleri

Bölüm adı	Kod	Açıklama	Örnek
Araştıralım	AR	“Araştıralım” başlığı ve büyüteç sembolü ile başlar. Açık yeşil çerçevesi ile diğer paragraf ve bölümlerden ayrılır. Öğrenilen kavramlar derinlemesine irdelenerek günlük hayatla bağlantıları için farklı kaynaklardan araştırılır ve sonuçlar sınıfta paylaşılır.	
Etkinlik	ET	“Etkinlik” başlığı ve bir sayfa üzerine konmuş büyüteç ve kalem sembolü ile başlar. Sarı bir fon ile diğer paragraf ve bölümlerden ayrılır. Bu bölümde öğrencilerin, verilen araç gereçleri kullanarak istenilen bilgiyi kendi gayretleriyle keşfetmeleri beklenir.	
Bunları Biliyor musunuz?	BB	“Bunları Biliyor musunuz” başlığı ile başlar. Özel bir fon ve üzerindeki kafasında 3 adet soru işareti bulunan bir insan kafasıyla diğer paragraf ve bölümlerden ayrılır. Bu bölümde öğrenilen konularla ilgili dikkat çekici öz bilgiler sunulur.	
Örnek	OR	“Örnek” başlığı ile başlar. Sayfada kahverengi çizgi ile çerçevelenmiş ‘Örnek’ bölümünde örnek sorular çözümleriyle yer almaktadır. Bu kısımda soru ve cevap bir bütün olarak kabul edilir.	
Proje	PJ	“Proje” başlığı ve değişik boylarda 3 dişli sembolü ile başlar. Ana metinlerden açık sarı fon ve yeşil çerçeve ile ayrılır. Keşfedilen bilgiler öğrencilerce bir sistem içinde uygulamaya dönüştürülür.	
Ünite giriş sayfası	UG	Bu bölüm her ünitenin, ünite başlığından sonra ilk sayfasında yer alır. Konu ile ilgili bir resim, ana konu başlıkları ve ünitede nelerin öğrenileceğine dair açıklamalardan oluşur.	

Tablo1. Kitap Bölümleri (Devam)

Bölüm adı	Kod	Açıklama	Örnek
Evde Uğraş	EU	"Evde Uğraş" başlığı ile başlar. Sarı fonu ve sol kenarında alt alta dizili noktalarıyla diğer bölüm ve paragraflardan ayrılır. Öğrencilerin bazı kazanımları genişletmek amacı ile sınıf dışında yapacağı çalışmaları içerir.	
Tartışalım	TR	"Tartışalım" başlığı ve kareli kâğıt üzerinde yer alan birbirine bakan iki kafa ve üzerinde değişik renklerdeki soru işaretleriyle hazırlanmış bir sembol ile başlar. Bazı yasa ve teorilerin gelişim süreçlerinin tartışılır.	
Ünite Soruları	US	"Ünite Soruları" başlığı ile başlar. Her ünitenin sonunda yer alan değişik soru çeşitlerini içeren değerlendirme sorularının yer aldığı bölümdür.	
Problem Çözelim	PC	"Problem Çözelim" başlığı ile başlar. Bir çerçeve ile diğer bölüm ve paragraflardan ayrılır. Fonu, yer aldığı ünite renginin açık tonudur. Günlük hayatta karşılaşılabilecek sorunlara çözüm aranır.	
Hiç düşündünüz mü?	HD	"Hiç Düşündünüz mü?" başlığı ile başlar. Ünite boyunca işlenecek konularla ilgili hazırlık için dikkat çekecek nitelikte ünitedeki ana amaçları içeren soruları kapsar. Her ünitenin giriş sayfasından sonraki ilk sayfadır.	
Ünite Bağlamı	UB	Ünitede geçen kavramlarla, günlük hayatta kullanılan teknolojik araç gereç veya olaylarla ilişki kurmak için yazılan bölümdür. Ünitelerde 'Hiç Düşündünüz mü' bölümünden sonra yer alır, bazı ünitelerde ise bu bölüme yer verilmemiştir.	

Tablo1. Kitap Bölümleri (Devam)

Bölüm adı	Kod	Açıklama	Örnek
Dikkat	DK	“Dikkat” başlığı ve kırmızı bir üçgen içerisinde beyaz bir ünlem işareti ile hazırlanmış bir sembol ile başlar. Bazı etkinliklerin ve araştırmaların gerçekleştirilmesi esnasında doğabilecek tehlikelere karşı alınması gereken tedbirleri içerir.	
Pekiştirelim	PK	“Pekiştirelim” başlığı ile başlar. Ünitede öğrenilen kavramların daha kalıcı hale getirilmesinin hedeflendiği bölümdür.	
Kutu	KT	Belli bir başlığı olmayan, ana metinden üniteden üniteye değişen renkteki fonu ile ayrılan bölümdür.	
Şema	SM	Bir çerçeve ile ana metinden ayrılmış şemaları kapsar.	
Okuma Parçası	OP	Bazı ünitelerin sonlarında bulunan okuma parçalarıdır. Ayrı bir sayfada başlar, mor renkli fonu ile ayırt edilir.	
Paragraf	PR	Ana metin içerisinde yer alan, anlam bütünlüğü taşıyan paragraf.	

C. Analiz Kuralları

İçerik analizi yapılırken dikkate alınması gereken kurallara aşağıda yer verilmiştir.

1. Analize başlamadan önce kod rehberini, kategorilere ve tanımlara hâkim oluncaya kadar okuyunuz ve dikkatlice inceleyiniz.

2. Analize başlamadan önce Ortaöğretim 9. Sınıf Fizik Kitabını inceleyiniz.

3. Analizin amacına uygun olması için belirtilen kayıt birimlerini belirtilen bağlam birimleri çerçevesinde ele alınız.

4. Kitap kodlanırken istenilen bağlamdan başlanabilir fakat kodlama işlemine getireceği kolaylık açısından ünite ünite ilerlenmesi, ünite içerisinde de kazanımların sırası ile takip edilmesi tavsiye edilir. Kitabı baştan sonra okur gibi ilerlenmesi kodlamayı kolaylaştırdığı gibi analizin amacına uygun olmasına da katkı sağlayacaktır.

5. Kodlama işleminde zorluk çekildiği zaman aynı bağlam birimi içerisinde kalarak o ya da bir önce/sonraki sayfada yer alan bir önce/sonraki bölümlere gidilir.

6. Bir bağlam birimi ve ünite bölümü birden çok kategoriyi barındırabilecekken, bir kayıt birimi sadece bir kategoriyle eşleştirilir.

7. Bir ünite bölümü içerisinde bir kategoriye ait bir kod tekrarlanıyorsa, tekrarlanan kod sadece bir defa kodlanır.

8. Bir ünite bölümü içinde bilimsel süreç becerilerine ait herhangi bir kodlama yapılmıyorsa o bölüm NA olarak kodlanır.

D. Kategoriler

İçerik analizinin en önemli aşaması, verilerin sınıflandırılacağı kategorileri belirlemektir (Simon, 1969). Her araştırmaya uygun, geliştirilmiş ya da standardize edilmiş kategoriler listesi söz konusu olmadığı için bu bölümde, bilimsel süreç becerileri için literatür çalışması ışığında belirlenmiş kategoriler tanımlanmıştır. Analiz yapan kişinin kategorilere hâkim olması çalışmanın güvenirliği için büyük önem taşımaktadır, çünkü bir içerik analizinin güvenirliği, kullanılan kategorilerin uygunluğu ve geçerliğine bağlıdır.

1. Gözlem Yapma (O)

Gözlem yapma, herhangi bir duyu organıyla veya farklı araç-gereçlerle nesne ya da olaylar hakkında doğrudan bilgi elde etmek için yapılan işlemdir (Carin, & Bass, 2001; Buxton, & Provenzo, 2007; Harlen & Qualter 2009). Beş duyunun (görme, koklama, duyma, tatma ve dokunma) ayrı ayrı ya da birlikte kullanılarak nesne ya da olaylar hakkında veri toplanmasıdır (Martin, 2006). Gözlem yaparken nesnelerin özelliklerine, hareket ya da yapılarındaki değişime, olaylardaki değişime dikkat edilir (Buxton, & Provenzo, 2007). Etkili bir gözlem, belirli bir amaç doğrultusunda dikkatli ve sistemli bir şekilde yapılır (Carin, & Bass, 2001). Gözlemler nitel ya da nicel olabilir. *Nitel gözlem* çiçeğin boyunun uzaması, yüzeyin pürüzlü olması, çürüyen bir meyvenin kokması gibi doğrudan duyu organlarıyla yapılan gözlemlerdir. *Nicel gözlem* ise nesne ya da olay ile ilgili verinin standart olan ya da olmayan birim cinsinden ifade edilerek yapılan gözlemlerdir (Martin, 2006). Örneğin çiçeğin boyunda meydana gelen değişikliği sayılarla ifade etmek nicel bir gözlemdir.

Gözlem yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	OKD1	Gözlem yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		OKD2	Bilim adamlarının gözlem yaptıklarını ifade eder.
		OKD3	Bilimde gözlemin önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	OKP1	Gözlem yapma becerisi hakkında bilgi verir, soru sorar.
		OKP2	Nasıl gözlem yapılması gerektiğini açıklar, soru sorar.
		OKP3	Gözlem yaparken dikkat edilmesi gerekenler hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	OSTP	Öğrenciye bir amaç belirtmeden gözlem yaptırır; öğrencinin sadece fiziksel olarak etkin olduğu fakat zihinsel olarak gözlemin amacını düşünmediği durumdur.
		OSTM	Öğrenciyi gözlem yapma becerisi; nasıl gözlem yapılması gerektiği hakkında düşündürür. Öğrenci fiziksel olarak bir gözlem yapmaz; fakat gözlem yapma becerisi hakkında düşünerek zihinsel olarak etkindir.
		OSTMP	Öğrenciye gözlem yaptırır. Nesnelerde meydana gelen değişimi duyularını kullanarak (görme, işitme, koklama, dokunma ve tat alma) belirlemesini ister. Öğrenciye belirli bir amaç doğrultusunda nitel gözlem yaptırır; Cisimlerin fiziksel özelliklerini, durumlarını, hareketlerini ve/veya bunlarda meydana gelen değişiklikleri betimlemesini ister.

Gözlem yapma kategorisi için örnek

> Gözlem, bir olayla ilgili olarak duyu organları ya da araç ve gereçler kullanılarak yapılan incelemelerdir. Fiziksel bir olay, duyu organlarıyla veya yukarıdaki teleskop örneğinde olduğu gibi duyu organlarını güçlendirebilecek birtakım teknolojik araçlarla gözlenir.
>
> Fizikle ilgili bir olay iki tür gözlem yapılarak incelenir. Bunlardan ilki, nitel gözlem, ikincisi ise nicel gözlemdir.
>
> Nitel gözlem, bir insanın beş duyusunu kullanarak yaptığı gözlem olarak tanımlanabilir. Örneğin Naz, üzerinden buhar çıkan bir miktar suyun sıcaklığını anlayabilmek için önce behere dokunuyor. Çıkan buhardan da hareketle beherdeki suyun sıcak olduğu yargısına varıyor. Bu yargıya "suya kendisi dokunarak" veya "sudan çıkan buharı bizzat gözlemleyerek" ulaşabilir mi? Herhangi bir ölçme aracı kullanmadan behere dokunduğunda sıcaklığı hissetmesi veya beherden çıkan buharı fark ederek "suyun sıcak olduğu yargısına varması" nitel gözleme örnek olabilir mi? Siz de nitel gözleme, yakın çevrenizden örnekler veriniz.
>
> Ortaöğretim Fizik 9/ Sayfa 23

Gözlem yapma kategorisi örneği için açıklama: Paragraf, gözlem hakkında bilgi verdiği için OKP1 olarak kodlanır.

2. Ölçme (S)

Ölçme en basit anlamda sayma ve kıyaslamadır; ölçülebilir büyüklükleri, standart ya da standart olmaya birimler cinsinden ifade etmektir. Ölçme işlemi standardize edilmiş aletlerle yapıldığı gibi standart olmayan yollarla da yapılabilir (Wolfinger, 2000). Örneğin bir odanın uzunluğu ölçen kişinin adımı ile ölçüldüğünde standart olmayan bir ölçüm cinsinden, bir metre yardımı ile ölçüldüğünde standart bir ölçüm birimi olan ‘metre’ cinsinden belirlenmiş olur. Ölçüm yapılarak, açıklama ve tahminlerin niteliği, tanımlamaların kesinliği arttırılır (Carin & Bass, 2001; Buxton & Provenzo, 2007).

Ölçüm yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	SKD1	Ölçüm yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		SKD2	Bilim adamlarının ölçümler yaptıklarını ifade eder.
		SKD3	Bilimde ölçmenin, ölçüm aracı kullanmanın önemini açıklar/ soru sorar.
		SKD4	Herhangi bir ölçümde kullanılan birim, birim dönüşümleri hakk. bilgi verir.
	İşlemsel Bilgi	SKP1	Ölçüm yapma becerisi hakkında bilgi verir, soru sorar.
		SKP2	Herhangi bir şeyin nasıl ölçüleceği hakkında bilgi verir, soru sorar.
		SKP3	Ölçüm yaparken dikkat edilmesi gerekenler hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	SSTP	Öğrenciye ölçüm yaptırır ve/veya ölçüm aracı yaptırır; öğrencinin sadece fiziksel olarak etkin olduğu fakat zihinsel olarak ölçüm yapma hakkında düşünmediği durumdur.
		SSTM	Öğrenciyi ölçüm yapma becerisi; nasıl ölçüm yapılması gerektiği hakkında düşündürür. Öğrenci fiziksel olarak bir ölçüm yapmaz; fakat ölçüm yapma becerisi hakkında düşünerek zihinsel olarak etkindir.
		SSTMP	Öğrenciden bir şeyi ölçmesini ve/veya ölçüm aracı geliştirmesini ister. Öğrenciden nicel betimleme yapmasını ister. SSTP den farklı olarak öğrenci bu durumda hem fiziksel hem de zihinsel olarak etkindir.

Ölçme kategorisi için örnek

Etkinlik / Farklı Maddelerle Yapılan Termometrelerle Aynı Sıcaklığın Ölçülmesi

Araç ve Gereçler

Civalı termometre, Alkollü termometre, Beher, Bunzen beki, Üçayak, Su

Nasıl Bir Yol İzleyelim?

1. Resimdeki düzeneği kurunuz.
2. Su kaynayıncaya kadar belli aralıklarla her iki termometrenin gösterdiği değerleri, aşağıdakine benzer bir çizelgeyi defterinize çizerek uygun yerlere yazınız.

Ölçümler	Alkollü Termometre	Civalı Termometre
1. Ölçüm		
2. Ölçüm		

(Örnek çizelgedir.)

Sonuca Varalım

1. Alkollü ve Civalı termometrelerle yaptığınız ölçümler arasında fark var mı?
2. Farklılık kaç dereceden sonra başladı?
3. Sizce hangi termometre sonuçları daha doğru gösterdi?
4. Alkollü termometre ile en son hangi değeri ölçebildiniz?

Ortaöğretim Fizik 9/ Sayfa 79

Ölçme kategorisi örneği için açıklama: Bu etkinlikte "Nasıl bir yol izleyelim" bölümünün 2. Maddesinde öğrencilerden iki farklı termometre ile ölçüm yapmaları ve bu verileri kaydetmeleri istenmektedir, bu durumda 2. Madde kayıt birimi öğrencilerden nicel verileri kaydetmesi istendiği için SSTMP olarak kodlanır.

3. Çıkarım Yapma (I)

Çıkarım, bir gözlem ya da olayın nedenleri hakkında en iyi *tahminin* yapılmasıdır (Martin, 2006). Önceki bilgi ve deneyimlere dayalı olarak gözlenen olayları yorumlamayı gerektirir (Carin & Bass, 2001; Buxton & Provenzo, 2007). Burada dikkat edilmesi gereken nokta, *çıkarım yapmayı tahmin etme becerisinden ayırt edebilmektir*. Tahmin etmek henüz gerçekleşmemiş bir olayın sonucunu önceden kestirebilmek iken, çıkarım yapmak gerçekleşmiş olayın nedenlerini açıklamaya yönelik fikir yürütmektir. Doğru ve etkili çıkarım yapmak için gözlem yapılmalı ve veriler toplanmalıdır. Bu bağlamda gözlem yapma ile çıkarım yapma becerileri arasındaki ilişkinin vurgulanması da önemlidir.

Çıkarım yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	IKD1	Çıkarım yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		IKD2	Bilim adamlarının çıkarımlarda bulunduklarını ifade eder.
		IKD3	Bilimde çıkarım yapmanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	IKP1	Çıkarım yapma becerisi hakkında bilgi verir, soru sorar.
		IKP2	Nasıl çıkarım yapılması gerektiğini açıklar, soru sorar.
		IKP3	Çıkarım yaparken dikkat edilmesi gerekenler hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	ISTP	Öğrenciye zihinsel bir süreç gerektirmeyecek şekilde çıkarım yaptırır. Bu durum kitapta öğrencinin çıkarım yapmasını istediği bölümün hemen ardından cevabın verildiği durumlar için kodlanabilir. Daha önce ifade edilmiş durumlar için de geçerlidir.
		ISTM	Öğrenciyi başka birisi(leri) tarafından yapılan bir çıkar hakkında düşündürür. Öğrenci çıkarım yapmaz, fakat yapılan çıkarım hakkında düşünerek nasıl yapılması gerektiği konusunda zihinsel olarak etkindir.
		ISTMP	Öğrenciden bir olayın nedenine dair açıklama yapmasını ister. Öğrencilerden bir olayın olası nedenleri hakkında verilere dayalı olarak tartışmalarını ister.

Çıkarım yapma kategorisi için örnek

> Otobüs durağında otobüs bekleyen bir yolcu, otobüsü kendine doğru hareket ediyor görür. Otobüsteki yolcular ise duraktaki yolcuyu kendine doğru hareket ediyormuş gibi görür. Bu örnekte olduğu gibi birinci etkinlikte Mehmet, Figen ve Ali'yi kendisine yaklaşıyor görürken. Figen ile Ali de Mehmet'i kendilerine doğru yaklaşıyormuş gibi görmektedir. Aynı şekilde Figen ile Ali de hızları eşit olduğundan birbirlerini duruyor gibi görmektedir.
>
> Burada Mehmet, Fazlı ve Yiğit, kaykay üzerindeki Figen ile Ali'yi aynı hızla hareket ediyor görürken Figen ise Ali'yi duruyor gibi görür. Bu durumun sebepleri sizce neler olabilir.
>
> Ortaöğretim Fizik 9/ Sayfa 128

Çıkarım yapma kategorisi örneği açıklama: Birinci paragraf, kitaptaki bir etkinlikten hemen sonra gelen bir açıklamadır. Etkinlikte gözlenen olay açıklandıktan sonra nedeni sorulduğu için, örnekteki ikinci paragraf ISTP olarak kodlanır.

4. Sınıflandırma (L)

Bilgilerin organize edilmesinde önemli bir yol olan sınıflandırma, nesne ya da olayların sahip oldukları benzer ve farklı özelliklerine göre gruplandırılmasıdır (Wolfinger, 2000). Sınıflandırma bilgi birikimi ve gözlem yoluyla elde edilen veriler doğrultusunda yapılır. Dikkat edilmesi gereken nokta sınıflandırma parametresinin açık ve net olması; sınıflandırma yapılırken herhangi bir karışıklığa neden olmamasıdır. Bu yüzden seçilen parametre öznel değil nesnel olmadır. Örneğin sinema filmlerini eğlenceli, sıkıcı, komik gibi kategorilere ayırmak yerine, filmleri türüne göre sınıflandırmak daha sağlıklı olur (Settlage & Southerland, 2007).

Sınıflandırma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	LKD1	Sınıflandırmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		LKD2	Bilim adamlarının çalışmalarında sınıflandırma yaptıklarını ifade eder.
		LKD3	Bilimde sınıflandırma yapmanın önemini açıklar ya da soru sorar.
		LKD4	Daha önce yapılmış bir sınıflandırma hakkında bilgi verir: sınıflandırma kriterleri, ve/veya sınıflandırmadaki ortak ve/veya farklı özellikler hakkında bilgi verir.
	İşlemsel Bilgi	LKP1	Sınıflandırma becerisi hakkında bilgi verir, soru sorar.
		LKP2	Sınıflandırmanın nasıl yapılması gerektiğini açıklar, soru sorar.
		LKP3	Sınıflandırma yaparken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	LSTM1	Nesne ya da olayların istenen ortak özelliklerini belirlemesi istenir. Nesne ya da olayların istenen farklı özelliklerini belirlemesi istenir.
		LSTM2	Nesne ya da olayları ilişkilerine göre düzenlemesi istenir. Verilen bilgiler doğrultusunda sınıflandırma yapması istenir. Bilinen bir sınıflandırmada grupların benzer özelliklerinin belirlenmesi/ ifade edilmesi/ tartışılması istenir. Bilinen bir sınıflandırmada grupları birbirinden ayıran özelliklerin ifade edilmesi/ belirlenmesi/ tartışılması istenir. Bilinen bir sınıflandırmada belirlenmiş olan parametre hakkında bilgi verir, soru sorar, düşündürür.
	Transfer Etme Becerileri	LSRM	Öğrencilerden kendisinin belirleyeceği kıstas(lar) doğrultusunda nesne ya da olayları sınıflandırması istenir.

Sınıflandırma kategorisi için örnek

> … Dikkatlice incelendiğinde doğada gerçekleşen bu döngünün farklı aşamalarında suyun katı, sıvı ve gaz halini görebiliriz. Su, buharlaşırken gaz; yağmur halinde iken sıvı; kar ve dolu yağışı sırasında katı haldedir.
>
> Fen ve teknoloji derslerinde maddeyi kütlesi, hacmi ve eylemsizliği olan nesne olarak tanımlamıştık. Dünya'mızı içtiğimiz suyun, soluduğumuz havanın, üzerinde yürüdüğümüz toprağın ve daha pek çok maddenin oluşturduğunu öğrenmiştik.
>
> Dünya'daki maddelerin ortak ya da farklı özelliklere sahip olduklarını hiç düşündünüz mü?
>
> Su döngüsünde minik damlanın bazen su, bazen buhar, bazen de dolu olarak seyahat ettiğini gözlemlemişsinizdir. Acaba bu damlanın bu üç durumunda tanımlanabilecek ortak özellikler var mıdır?
>
> Ortaöğretim Fizik 9/ Sayfa 92

Sınıflandırma kategorisi örneği için açıklama: Bu ana metinden alınan kesitteki paragrafta, maddelerin hallerine göre sınıflandırılması (katı, sıvı, gaz) hakkında bilgi verildikten sonra, maddenin bu üç farklı durumunda ortak olan özellikleri sorulmuştur. Bu durumda paragraftaki cümle kayıt birimi, LSTM2 olarak kodlanır.

5. Tahmin Etme (P)

Tahmin etme, henüz gerçekleşmemiş bir olayın olası sonucunu, deneyime ya da verilere dayanarak öngörüde bulunmaktır. (Buxton & Provenzo, 2007). Tahmin etmeyi, çıkarım yapma becerisinden ayıran özelliği tahmin etmenin gelecekteki bir olay ile ilgili olmasıdır. Çıkarım yaparken ise gerçekleşmiş olayın sonucuna etki eden olası faktörler hakkında fikir yürütülür (Carin & Bass, 2001).

Bilimsel araştırma, sürekli bir tahmin etme ve yapılan tahmini doğrulama ya da çürütme işlemidir. Tahminler doğru, yanlış ya da eksik olabilir: olay beklendiği gibi ya da beklenenden farklı sonuçlanabilir. Bu noktada önemli olan yapılan tahminin doğru, yanlış ya da eksik olup olmadığının test edilerek öğrenilmesidir (Martin, 2006; Wolfinger, 2000).

Tahmin etme kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	PKD1	Tahmin etmenin bilimsel süreç becerilerinde biri olduğunu ifade eder.
		PKD2	Bilim adamlarının çalışmalarında nesne ya da olaylar hakkında tahminlerde bulunduklarını ifade eder.
		PKD3	Bilimde tahmin etmenin önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	PKP1	Tahmin etme becerisi hakkında bilgi verir, soru sorar.
		PKP2	Verilere dayanarak nasıl tahmin yürütülebileceğini açıklar, soru sorar.
		PKP3	Bir olay hakkında tahmin yapılırken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	PSTM1	Öğrenciyi, toplanan verilere ya da yapılan gözlemlere dayanarak neler tahmin yürütülebileceği üzerine düşündürür.
		PSTM2	Öğrencinin gelecekteki bir olay, etkinlik ya da deneyin muhtemel sonuçları hakkında gözlem ve tecrübeye dayalı olarak tahminde bulunmasını ister.
		PSTM3	Öğrenciden, değişkenler arasındaki ilişkiden yararlanarak yeni bir değişkenin olası etkilerini önceden kestirmesini ister.

Tahmin etme kategorisi için örnek

Etkinlik/ Su Akışını Gözlemleme

Araç Gereçler

2 adet boş sıvı deterjan kabı, lastik hortum (15-20cm), renklendirilmiş su

Nasıl Bir Yol izleyelim?

1. Beş veya altı kişilik gruplar oluşturunuz ve aşağıdaki etkinlik basamaklarını dikkate alarak görev paylaşımı yapınız.
2. Şekildeki düzeneği kurunuz.
3. Kaplara önce farklı, sonra aynı yükseklikte su koyarak muslukları açtığınızda su akışı olup olamayacağını tartışarak bir öngörüde bulununuz.
4. Muslukları açarak su akışının olup olmadığını gözleyiniz.

Sonuca Varalım

1. Öngörünüzle gözleminiz arasında bir fark var mı?
2. Hangi durumda su akışı olmuştur ve ne zamana kadar devam etmiştir?
3. Su akışı hangi kaptan hangi kaba olmuştur?

Ortaöğretim Fizik 9/ Sayfa 182

Tahmin etme kategorisi örneği için açıklama: Bu etkinlikte deney düzeneği kurulduktan sonra, herhangi bir işlemde bulunmadan önce yapılacak olan müdahalenin sonucuna yönelik tahminde bulunulması istenmektedir. İki kap arasındaki musluk açılmadan önce, açıldığında kaplar arasında su akışı olup olmayacağının tahmin edilmesi beklenmektedir. Bir sonraki adımda yapılan tahminin doğru, yanlış ya da eksik olup olmadığının anlaşılması için musluk açılıyor ve yapılan tahmin gerçekleşen sonuç ile karşılaştırılıyor. Bu durumda bu etkinlikte "Nasıl bir yol izleyelim" bölümündeki 3. Madde (kayıt birimi) PSTM2 olarak kodlanır.

6. Bilimsel İletişim Kurma (C)

İletişim kurma, düşünce ve/veya yorumların sözlü ya da yazılı şekilde başkalarına aktarılması, paylaşılmasıdır (Martin, 2006; Wolfinger, 2000). Bilimsel iletişim kurma ise, bilimsel bir çalışmanın herhangi bir bölümünün ya da hepsinin başkaları ile paylaşılması, yapılan çalışma hakkında tartışılmasıdır. Bilimsel iletişim kelimeler, tablolar, grafikler, modeller, kavram haritaları ve benzerleri gibi sembolik gösterimlerle kurulabilir. Bilimin ilerlemesi için, yapılan çalışmaların paylaşılması, sorgulanması ve analiz edilmesi büyük önem taşıdığı gibi, yapılan bir çalışmanın tekrarlanabilmesi için de önemlidir (Buxton, & Provenzo, 2007).

Bilimsel iletişim kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	CKD1	Bilimsel iletişim kurmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		CKD2	Bilim adamlarının deney ve gözlemlerden elde etikleri verileri diğer bilim adamlarının incelemesi/ onaylaması /yeniden denemeleri için paylaştıklarını ifade eder.
		CKD3	Bilimsel verilerin paylaşılması, tartışılması, sorgulanması veya analiz edilmesinin bilimin ilerlemesi için gerekli olduğunu vurgular, düşündürür. Bilimsel bilginin oluşması ve yayılmasında iletişimin etkisini vurgular.
	İşlemsel Bilgi	CKP1	Bilimsel iletişim kurma becerisi hakkında bilgi verir, soru sorar.
		CKP2	Bilimsel iletişimin nasıl kurulması gerektiğini açıklar, soru sorar.
		CKP3	Bilimsel iletişim kurarken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	CSTP	Yazılı kaynaklardan yapılan araştırmanın başkaları ile paylaşılmasını ister. Öğrenci kendinden bir şey katmaz araştırmaya, var olan bilgiyi araştırır ve bulduklarını paylaşır.
		CSTM	Bilimsel iletişim kurma hakkında öğrenciyi düşündürür. Öğrenci fiziksel olarak bir sunum yapmaz ya da başkalarıyla tartışmaz ama yaptığı bilimsel çalışmayı başkalarına nasıl aktaracağı hakkında düşünür.
		CSTMP	Gözlem, elde edilen veriler, çıkarım ve/veya tahmin, hipotez, değişkenlerin nasıl kontrol edildiği, tasarlanan deneyler, ulaşılan sonuçlar, yapılan bir araştırma hakkında elde edilenlerin, düşünce ve/veya yorumların paylaşılmasını ister. Yapılan bilimsel bir çalışma; deney, gözlem vs. hakkında sunum yaptırır. Yapılan bir çalışma, deney, gözlem vs. hakkında rapor hazırlatır.

Bilimsel iletişim kurma kategorisi için örnek

> Proje
>
> … Oluşturduğunuz elektrik motorunu sınıfta çalıştırarak, çalışma prensiplerini arkadaşlarınıza anlatınız.
>
> Ortaöğretim Fizik 9/ Sayfa 204

Bilimsel iletişim kurma kategorisi örneği için açıklama: Kitabın bu “Proje” bölümünde öğrencilerden, basit bir elektrik motoru tasarlamaları istenmektedir. 2 hafta süren çalışma sonucunda tasarladıkları elektrik motorunu sınıfta çalıştırmaları ve motorun çalışma prensibini anlatmaları beklenmektedir. Dolayısıyla, Proje bölümdeki son paragraf CSTMP olarak kodlanır.

7. Hipotez Kurma (H)

Hipotez, değişkenler arasında öne sürülen ilişkiyi düşünce, tecrübe ve gözleme dayalı olarak açıklamaya yönelik yapılan test edilebilir önermelerdir (Martin, 2006). Problem ya da bir sorun hakkında hipotez kurulabileceği gibi bazı olay ve özellikleri ya da değişkenler arasındaki ilişkileri ortaya çıkarmak için de bir önerme ileri sürülebilir. Tahmin etme, henüz gerçekleşmemiş bir olayın olası sonucuna yönelik olmasına karşın hipotez, bağımsız değişkenin bağımlı değişken üzerine etkisinin nasıl olacağını öne süren bir çeşit tahmindir (Bailer, Raming, Ramsey, 1995). Hipotez deneyin odağını belirlediği için, araştırmacıya hangi veriler üzerinde yoğunlaşması gerektiği konusunda rehberlik eder. Hipotez kurulurken önemli olan nokta doğru olması değil test edilebilir olmasıdır. Hipotez kurulduktan sonra, çeşitli yöntemlerle test edilerek ifadenin doğruluğu sınanmalıdır (Raming & Ramsey, 2006).

Hipotez kurma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	HKD1	Hipotez kurmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		HKD2	Bilim adamlarının çalışmalarında hipotez kurduklarını ifade eder, hipotezlerine yer verir.
		HKD3	Bilimde hipotez kurmanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	HKP1	Hipotezin ne olduğu ve/veya nasıl kurulduğunu anlatır, soru sorar.
		HKP2	Nasıl hipotez kurulması gerektiğini açıklar; iyi bir hipotezin özellikleri (rasyonel olmak, açık ve işlemsel olarak tanımlanabilir olmak, sınanabilir olmak) hakkında bilgi verir, soru sorar.
		HKP3	Hipotez kurarken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	HSTM1	Verilen ya da kendi oluşturduğu bir hipotezin, iyi bir hipotezde olması gereken özellikler bakımından değerlendirilmesini ister.
		HSTM2	Bir önermenin araştırılıp araştırılmayacağının belirlenmesini ister.
			Bir olayı ya da ilişkiyi açıklamak, deney ya da araştırma için test edilebilir bir hipotez kurulmasını ister.

Hipotez kurma kategorisi için örnek

… Bilimsel çalışmaları diğer çalışmalardan ayıran en önemli fark, bilimsel çalışmaların verilere dayalı olmasıdır. Bilimsel bir çalışmada en başta, incelenecek bir probleme ihtiyaç vardır. Problem belirlendikten sonra problem durumunu açıklayan verileri elde etmek için deneyler, gözlemler, inceleme ve araştırmalar yapılır. Veriler toplandıktan sonra bazı hipotezler kurulur. Peki, hipotezin ne olduğunu biliyor musunuz?

Hipotez, bilimsel bir problemin verilere dayalı olarak kurulan geçici çözüm yoludur. Bilimsel bir hipotez, incelenen probleme bir ölçüde cevap verebilmeli ve eldeki tüm verileri içermelidir. Bilimsel bir hipotezin bir takım deneylerle geçerli olup olmadığı test edilebilmelidir. Bundan sonra kontrollü deneyler yapılarak hipoteze dayalı tahminlerin dolayısıyla hipotezin geçerliliği ve doğruluğu araştırılır. Bu işlem, deney sonuçlarını tahminlerle karşılaştırılarak yapılabilir. Bu kontrollü deneylerden sonra elde edilen verilerin, kurulan hipotezleri destekleyip desteklemediğine, eğer gerekiyorsa ne ölçüde desteklediğine karar verilir.

Bilim insanları, çalışmaları boyunca sürekli olarak veri toplarlar ve bu verilere dayalı olarak bir takım açıklamalar yaparlar. Bilim insanları topladıkları verilere bağlı olarak inceledikleri problemi çözebilmek için önce bir dizi hipotez kurarlar. Bu hipotezler, kurulduktan sonra sürekli bir "test etme" sürecine tabi tutulur. Bu süreçte bazı hipotezler, deneysel olarak güçlü destek bulur ve önem kazanır; bazılarının da geçerli olmadığı sonucuna varılır.

Ortaöğretim Fizik 9/ Sayfa 39

Hipotez kurma kategorisi örneği için açıklama: Bu metindeki 2. ve 3. paragraf kayıt birimlerinde bilimsel yöntem ile başlayarak, hipotez kurma becerisini ve bilim adamlarının çalışmalarında sürekli olarak hipotez kurup test ettiklerini anlatılmaktadır. 2. paragraf kayıt birimi HKP1 ve 3. Paragraf kayıt birimi HKD2 olarak kodlanır.

8. Değişkenleri Belirleme ve Kontrol Etme (V)

Değişkenleri belirleme, yapılacak deneyi etkileyebilecek bütün faktörlerin ifade edilmesidir. Değişkenleri kontrol etme ise değiştirilmesi ve/veya sabit tutulması gereken değişkenlerin belirlenmesi ve etkisi test edilecek değişken (bağımsız değişken) haricindeki değişkenlerin sabit tutularak sadece bağımsız değişkenin değiştirilmesidir (Arthur, 1993). Deney sonucuna hangi koşulun etki ettiğini bulmak için sadece bir değişken değiştirilir (Peters, & Stout, 2006). Böylece deneyde bağımlı değişkene etki eden bağımsız değişkenin etkisi açıklanabilir.

Değişkenleri belirleme ve kontrol etme kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	VKD1	Değişkenleri belirlemenin ve/veya kontrol etmenin bilimsel süreç becerilerinden biri olduğunu ifade eder.
		VKD2	Bilim adamlarının yaptıkları deneylerde aşağıdaki bilgilerden biri, bir kaçı ya da hepsine yer verir: Değişkenleri belirleyip, tanımladıklarına, Deney süresince değişkenleri nasıl kontrol ettiklerine, Hangi değişkeni değiştirdikleri ve buna nasıl karar verdiklerine, Deney sonunda elde edilen bilgilerden nasıl sonuca ulaştıklarına.
		VKD3	Bilimde değişkenleri belir.ve/veya kontrol et.nin önemini açıklar, soru sorar.
	İşlemsel Bilgi	VKP1	Değişkenlerin belir. ve/veya kontrol etme hakkında bilgi verir, soru sorar.
		VKP2	Değişkenlerin nasıl belirlenmesi ve/veya kontrol edilmesi gerektiğini açıklar, soru sorar.
		VKP3	Değişkenleri belirlerken ve/veya kontrol ederken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	VSTP	Deney sırasında hangi değişkenlerin nasıl kontrol edileceğini söyleyerek öğrenciden yapmasını ister. Öğrenci fiziksel olarak etkindir fakat değişkenleri nasıl kontrol edeceği söylendiği için zihinsel olarak etkin değildir.
		VSTM1	Öğrenciden bir durum, olay ya da deney için değişkenleri belirlemesini, bağımsız, bağımlı ve kontrol edilmesi gereken değişkenleri belirlemesi istenir. Öğrenci sadece zihinsel olarak etkindir, önünde fiziksel bir ortam bulunmamaktadır değişkenleri manipüle etmek için.
		VSTM2	Öğrenciden kurgulanan bir deney, durum ya da olay için değişkenleri belirlemesi ve/veya tanımlaması istenir. Öğrenciden kurgulanan bir deney sırasında değişkenlerin nasıl kontrol edilebileceği üzerine düşünmesi istenir. Öğrenci fiziksel olarak etkin değildir fakat değişkenlerin kontrol edilmesi hakkında düşündüğü için zihinsel olarak etkindir.
		VSTMP	Bir durum, olay ya da deney için aşağıdaki maddelerinden en az birini, bir kaçını ya da hepsini yaptırır: Değişkenlerin belirlenmesi, tanımlanması, sabit tutulacak değişkenlerin belirlenmesi, bağımsız değişkenin belirlenmesi, bağımlı değişkenin belirlenmesi, kontrol edilemeyen değişkenlerin belirlenmesi, bağımsız değişkenin nasıl değiştirileceğine karar verilmesi, deney sonucunda iki değişken arasındaki ilişkinin ortaya konması, beklenmedik bir sonuca ulaştığında, neden beklendiği şekilde sonuçlanmadığını değişkenler üzerinden sorgulanması.

Değişkenleri belirleme ve kontrol etme kategorisi için örnek

Problem Çözelim

Problem Durumu

Bir nakliyat firmasının bir şehirden başka bir şehre aynı sürede nakledeceği yük miktarı artmıştır. Firma sahibi, nakil işlemini gerçekleştiren personelden yük naklini yine tek bir araçla yapmasını istemektedir. Personel bu sorunu nasıl çözmelidir?

Nasıl Bir Yol İzleyelim

1. Bu problemde aşağıdaki değişkenleri belirleyiniz.
   Bağımlı değişkenler:……………..
   Bağımsız değişkenler:…………….
   Kontrol değişkenleri:………………
2. Bu değişkenleri kullanarak problemi nasıl çözeceğinizi ayrıntılı olarak yazınız

Yükün aynı sürede nakledilmesi için aracın hareket ivmesinin değişmemesi gerekir. Yükün artması, aynı ivmeyi kazanabilmesi için daha büyük kuvveti gerektirir. Süre, sabit kaldığı için kontrol değişkeni; yük miktarı, kuvveti belirlediğinden bağımsız değişken; kuvvet ise bağımlı değişkendir.

Ortaöğretim Fizik 9/ Sayfa 153

Değişkenleri belirleme ve kontrol etme kategorisi örneği için açıklama: Kitabın bu "Problem Çözelim" bölümünde, verilen bir durum için öğrencilerden bağımlı, bağımsız ve kontrol edilen değişkenleri belirlemesi istenmektedir. Bu nedenle problem çözelim kayıt birimi VSTM1 olarak, sonrasında gelen paragraf bu konu ile ilgili açıklama yaptığından paragraf kayıt birimi VKP1 olarak kodlanır.

9. Deney Tasarlama ve Yapma (E)

Deney yapma, diğer becerileri kapsayan en karmaşık beceridir. Deney yapmanın temel amacı tahmin ya da hipotezlerin sınanmasıdır: belirlenen bağımsız değişkenin bağımlı değişken üzerindeki etkisini ortaya çıkarmak için etkili planın yapılmasıdır (Martin, 2006). Deney yapma becerisi; yapılan tahmin ya da kurulan hipotez doğrultusunda uygun araç gereçleri seçme, bu araç gereçleri doğru bir şekilde kullanma, deney amacına uygun düzeneği kurma, değişkenleri kontrol ederek veriler elde etme, bu verilerle rasyonel bir sonuca vararak tahmini ya da hipotezi değerlendirme becerilerini kapsar (Settlage & Southerland, 2007). *Deney yapma becerisi diğer tüm becerileri kapsadığı için ayırt etmek zor olabilir. Bu yüzden kayıt biriminde aşağıdaki koşulların her biri aranmalıdır:*

- Başlamadan önce deneyin sonucuna dair tahmin yürütülmesi ya da iki değişken arasındaki ilişkiyi açıklayacak bir hipotezin kurulması

- Yapılan tahmin ya da kurulan hipotezin test edilmesi.

Deney tasarlama ve yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	EKD1	Deney yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		EKD2	Bilim insanlarının deney tasarladıklarını ve yaptıklarını ifade eder.
		EKD3	Bilimde deney tasarının ve yapmanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	EKP1	Deney yapma becerisi hakkında bilgi verir, soru sorar.
		EKP2	Nasıl deney tasarlanması ve/veya yapılması/ Deney malzemelerinin nasıl kullanılması gerektiğini açıklar, soru sorar.
		EKP3	Deney yaparken dikkat edilmesi gerekenler hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	ESTP	Öğrencilere adımları belirlenmiş bir deney, aşağıdaki koşulların hepsini sağlayacak şekilde yaptırılır; • Deneyin sonucunu tahmin edilmesi ya da hipotez kurulmasını ister • Deney düzeneğini öğrencinin kurmasını ister • Verileri öğrencinin kaydetmesini ister • Öğrencinin verileri yorumlamasını ister • Öğrencinin deneyde elde edilen sonuç doğrultusunda tahminin ya da hipotezin doğruluğuna karar vermesini ister
		ESTM	Öğrenciden fiziksel olarak deney yapmasını istemez, fakat bir hipotezi sınamak için nasıl bir deney düzeneği kurulması gerektiği hakkında düşündürür.
		ESTMP	Öğrenciden yapılacak bir deney için uygun araç gereçleri seçmesini ister/ Bir hipotezi sınamak, yapılan bir tahmini test etmek, değişkenler arasındaki ilişkiyi belirlemek ya da bir soruya cevap vermek amaçlarından herhangi biri için öğrencinin özgün bir deney (düzeneğinin) tasarlamasını ister.

Deney tasarlama ve yapma kategorisi için örnek

> Etkinlik/ Hipotez Kuralım
>
> Araç ve Gereçler
>
> Plastik su şişesi, izole bant, Çivi ve Su
>
> Nasıl Bir Yol İzleyelim?
>
> 1. Beş veya altı kişilik gruplar oluşturunuz ve aşağıdaki etkinlik basamaklarını dikkate alarak görev paylaşımı yapınız.
> 2. Elinizdeki plastik su şişesinin üzerine aynı düşey doğrultuda üç adet delik açınız. Bu deliklerin üzerini bantla kapatınız.
> 3. Şişeye su doldurarak kapağını kapatınız.
> 4. En üstteki deliğin üzerindeki bandı çıkarırsanız ne olacağıyla ilgili tahminler yapınız.
> 5. Bu işlemi gerçekleştirdiğinizde ne olduğunu gözlemleyiniz.
> 6. Tahmin ettiğiniz şey gerçekleşti mi? Cevabınız evet veya hayır olacaktır. Bunun sebebini nasıl açıklarsınız? (Bu açıklamalar sizin hipotezlerin izdir.)
> 7. Bu hipotezlerinizin geçerli olup olmadığını test etmek için şişe üzerindeki diğer delikleri açarak deneyi yeniden yapınız.
>
> Sonuca Varalım
>
> 1. Hipotezlerin test edilmesi için niçin deneylere ihtiyaç vardır?
> 2. Bir hipotezin iyi olup olmadığını iddia edebilir misiniz? Neden?
>
> Ortaöğretim Fizik 9/ Sayfa 39

Deney tasarlama ve yapma kategorisi örneği için açıklama: Bu etkinlikte öncelikle öğrencilerden deney sonucu hakkında bir hipotez kurmaları istenmektedir (Nasıl Bir Yol İzleyelim, 6. Madde). Öğrencilerden, kurdukları hipotezi sınamak için etkinlikte verilen basamakları yerine getirmeleri beklenmektedir. Bu durumda, bu etkinlik bir bütün olarak, aynı zamanda kayıt birimi olarak, ESTP olarak kodlanır.

10. Veri Toplama, Yorumlama (D)

Tahmin veya hipotez ışığında nitel ve/veya nicel veri toplayabilmek, verileri çeşitli formlara (tablo, grafik, çizelge vb.) dönüştürebilmek, verileri akla uygun yorumlayarak bağımlı-bağımsız değişken arasındaki ilişkiyi belirleyebilme becerisidir (Ramign, & Ramsey, 2006; Martin, 2006; Wolfinger, 2000). Önemli olan (a) toplanan verilerin amaca uygun olması, (b) geçerli bir sonuca ulaşmak için en uygun formda düzenlenmesi ve (c) veriler üzerinde düşünerek akla uygun sonuçların çıkarılmasıdır.

Veri toplama ve yorumlama kodları

<table>
<tr><th></th><th>Tür</th><th>Kod</th><th>Açıklama</th></tr>
<tr><td rowspan="6">Bilgi Boyutu</td><td rowspan="3">İfadesel Bilgi</td><td>DKD1</td><td>Veri toplamanın, verileri sistematik bir şekilde düzenlemenin, bilgilerden arındırmanın ve/veya yorumlamanın bilimsel süreç becerilerinden biri olduğunu ifade eder.</td></tr>
<tr><td>DKD2</td><td>Bilim insanlarının düzenli bir biçimde verileri topladıkları, organize ettikleri ve/veya akla uygun bir şekilde yorumladıklarını ifade eder.
Bilim adamlarının veri toplama ve yorumlama çalışmalarına ait detaylı örneğe yer verir (Sadece 'şu verileri toplamıştır' gibi genel cümleler değil, verilerin nasıl toplandığı, nasıl organize edildiği, bu süreçte nelere dikkat edildiği gibi detaylı bilgilerin verildiği ifadelere yer verir)</td></tr>
<tr><td>DKD3</td><td>Bilimde veri toplamanın ve yorumlamanın önemini açıklar ya da soru sorar.</td></tr>
<tr><td rowspan="3">İşlemsel Bilgi</td><td>DKP1</td><td>Veri toplama ve yorumlama becerisi hakkında bilgi verir, soru sorar.</td></tr>
<tr><td>DKP2</td><td>Nasıl veri toplanması ve/veya yorumlaması gerektiğini açıklar, soru sorar. Yapılan bir çalışmaya ait verilerin nasıl düzenlendiğiyle ilgili örnek verir.</td></tr>
<tr><td>DKP3</td><td>Veri topl. sürecinde dikkat edilmesi gerekenler hk.da bilgi verir, soru sorar.</td></tr>
<tr><td rowspan="4">Beceri Boyutu</td><td rowspan="2">Görev Becerileri</td><td>DSTP</td><td>Öğrenciden veri toplanmasını ister: Öğrenciden yaptığı gözlemde elde ettiği verileri not etmesini ister, Öğrenciden değişkenlerle yaptığı denemelerle veri toplamasını ister.</td></tr>
<tr><td>DSTM</td><td>Toplanan verilerin düzenlenmesini ister: Verilerin, deneyin sonucunu etkilemeyecek ve/veya karışıklığa yol açacak gereksiz bilgilerden arındırılmasını ister. Herhangi bir formda (düz yazı, grafik, tablo, sütunlu grafik vb. gibi) verilen verilerin başka bir forma (düz yazı, grafik, tablo, sütunlu grafik vb. gibi) dönüştürülmesini ister.</td></tr>
<tr><td rowspan="2">Transfer Etme Becerileri</td><td>DSR1</td><td>Verilerin yorumlanmasını ister. Verileri yorumlarken görsel formlardan (grafik, tablo, sütunlu grafik vb. gibi) faydalanılmasını ister. Verilen bir görsel formu (grafik, tablo vb. gibi) yorumlamalarını ister.
Yapılan tahminler ile deney/gözlemde elde edilen verilerle ulaşılan sonuçların karşılaştırılmasını ister. Verileri yorumlayarak bir sonuca ulaşılmasını ister.</td></tr>
<tr><td>DSR2</td><td>Öğrencilerden elde edilen sonuçların genel uygulanabilirliği hakkında varsayımda bulunmasını ister.</td></tr>
</table>

Veri toplama ve yorumlama kategorisi için örnek

> Naz'ın fizikle ilgili bir olayı incelerken o olaya etki eden veya etmeyen faktörleri yalnızca gözlem yaparak belirleyebilmesi her zaman mümkün olmaz. Bu gibi durumlarda fizikçiler, doğal ortamda veya laboratuvarda birtakım deneyler yaparak çeşitli veriler toplarlar. Bu deneylerde, fen ve teknoloji derslerinde yaptığınız deneylere benzer şekilde; bağımlı, bağımsız değişken ve kontrol değişkenleri belirlenir. Bu şekilde, kontrol değişkenleri kullanılarak bağımsız değişkenlerin bağımlı değişkenler üzerindeki etkileri açıklanmaya çalışılır. Fizikçiler, deney yoluyla elde ettikleri verileri yorumlayarak açıklarlar.
>
> Ortaöğretim Fizik 9/ Sayfa 24

Veri toplama ve yorumlama kategorisi örneği için açıklama: Bu paragrafta bilim adamlarının deneyler yaparak veri topladıkları ve bu şekilde elde ettikleri verileri yorumladıkları vurgulandığı için DKD2 olarak kodlanır.

11. Model Yapma (M)

Model, beş duyu organıyla algılanması mümkün olmayan nesne, kavram, olgu veya sistemin beş duyu organıyla anlaşılır ve kavranabilir somut ve görsel bir forma sokulmuş halidir. Herhangi bir obje, çizim, matematiksel eşitlik, bilgisayar programı ve benzeri şeyler model olabilir. Modeli değerli kılan, bir şeyin nasıl çalıştığının anlaşılmasına yardımcı olma özelliğidir (Wolfinger, 2000; Martin, 2006).

Model yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	MKD1	Model yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		MKD2	Bilim adamlarının anlaşılması güç kavramların, nesne ve olayların modellerini yaparak anlaşılır hale getirdiklerini ifade eder. Bilim adamlarının yaptıkları modeller hakkında detaylı bilgi verir. (Modeli kimin geliştirdiği, gerçek halini nasıl algıladığı ve gerçeği ile modeli arasındaki benzerlik ve farklılıkları hakkında bilgi verir)
		MKD3	Bilimde model yapmanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	MKP1	Model yapma becerisi hakkında bilgi verir: Verilen model ile gerçek nesne/olay arasındaki benzerlikleri vurgular, soru sorar.
		MKP2	Nasıl model yapılması gerektiğini açıklar. Olay, nesne ya da fikirleri açıklamak için -aşağıdaki koşulları sağlayarak- model kullanılır: • Anlatılanın gerçeğinin modeli olduğunu vurgular. • Gerçeği ile benzer ve farklılıkları hakkında bilgi verir.
		MKP3	Modelleme yapılırken nelere dikkat edilmesi gerektiğini ifade eder; Model yapabilmek için gerçeği hakkında mümkün olduğunca fazla veri toplamanın önemli olduğunu ifade eder, soru sorar.
Beceri Boyutu	Görev Becerileri	MSTP	Öğrenciden daha önce yapılmış bir modeli yapmasını ister.
		MSTM	Öğrencinin model ile gerçeği (nesne, olay, kavram, sistem vb.) arasındaki benzerliklerin ve/veya farklılıkları bulmasını ister.
		MSTMP	Daha önce yapılmış bir modeli kullanarak olaylar ya da kavramlar arasındaki ilişkinin açıklanmasını ister. Herhangi bir formda (örn: üç boyutlu nesne) olan nesneyi temsil edecek ya da açıklayacak başka bir forma (örn: iki boyutlu bir çizim) dönüştürülmesini ister. Yeni bir kavram/ olay için özgün bir modelin geliştirilmesini ister.

Model yapma kategorisi için örnek

Etkinlik /Model Kuralım

Araç ve Gereçler

Bir adet kapalı kutu, cetvel, hesap makinesi, milimetrik kâğıt.

Nasıl Bir Yol İzleyelim?

1. Beş ya da altı kişilik gruplar oluşturunuz ve aşağıdaki etkinlik basamaklarını dikkate alarak görev paylaşımı yapınız.
2. Gruptaki arkadaşlarınızla çalışarak, size verilen kutunun içyapısının nasıl olduğuyla ilgili birtakım veriler toplamaya çalışınız.
3. Elde ettiğiniz verileri kullanarak kutunun içyapısını en iyi açıklayabilecek bir model çizimi yapınız.
4. Bu modelin verilerinizle nasıl bir ilişkisi olduğunu grup arkadaşlarınızla tartışınız.

Sonuca Varalım

1. Kurduğunuz modeli, diğer grupların modelleriyle karşılaştırınız.
2. Bu modellerden hangisinin en iyi olduğunu söyleyebilir misiniz? Neden?
3. Bilim insanlarının model oluşturma süreciyle sizin model oluşturma süreciniz arasında benzerlik var mı?

Ortaöğretim Fizik 9/ Sayfa 42

Model yapma kategorisi örneği için açıklama: Bu etkinlikte, öğrencilerden üç boyutlu olan bir kutunun içyapısı hakkında veri toplamaları ve bu veriler doğrultusunda kutunun içyapısını en iyi şekilde ifade edecek bir çizim yapmaları istenmektedir (Nasıl Bir Yol İzleyelim, 2. ve 3. maddeler). Bunun yanında yapılan tüm modellerin karşılaştırılması ve en iyi çizilmiş modele karar verilmesi de istenmiştir (Sonuca Varalım, 1. ve 2. madde). Etkinliğin son maddesinde öğrencilerden bilim adamlarının model geliştirme süreçleri ile kendilerinin bu etkinlikte yaptıklarını karşılaştırmaları istenmektedir (Sonuca Varalım, 3. madde). Bu durumda bu etkinlikte yer alan “Nasıl bir yol izleyelim” bölümündeki 2. ve 3. Maddeler (kayıt birimleri) MSTMP olarak kodlanır.

APPENDIX C

PROGRAM İÇİN BİLİMSEL SÜREÇ BECERİLERİ KOD REHBERİ

A. Analiz Birimleri

Bu içerik analizinde kodlama işlemi, kayıt birimi ve bağlam birimi dikkate alınarak yapılır. Kayıt birimi, "iletişim içeriğinin belli bir kategoriye yerleştirilecek olan en küçük çözümleme birimidir. Bağlam birimi ise, kayıt birimini değerlendirmek için, içinde yer aldığı bağlamı sınırlandıran en geniş bölümdür (Tavşancıl, & Aslan, 2001). Kullanılan birim türleri analiz edilen belgenin niteliğine ve içeriğine göre değişiklik gösterdiğinden dolayı incelenecek her belge için ayrı ayrı tanımlanmalıdır. Ortaöğretim 9. Sınıf Fizik Dersi Öğretim Programı içerik analizi için belirlenen bağlam ve kayıt birimleri aşağıda detayları ile tanımlanmıştır.

Bağlam Birimleri

Bu çalışmada, 9. Sınıf Fizik Dersi Öğretim Programında yer alan bölümler ve alt başlıkları bağlam birimi olarak alınmıştır. Programdaki içerik sayfasına uygun şekilde sıralanan bağlam birimleri şöyledir;

Bağlam Birimi Olarak Tanımlanan Bölümler

1. Fizik Dersi Öğretim Programı'nın Temelleri

    1.1.Fizik Dersi Öğretim Programı'nın Felsefesi ve Vizyonu

    1.2.Fizik Dersi Öğretim Programı'nın Gerekçesi ve İhtiyaç Analizi Çalışmaları

        1.2.1.Fizik Dersi Öğretim Programları Uygulamalarının Tarihsel Gelişimi

        1.2.2. TTKB-Ortaöğretim Fizik Dersi Öğretim Programı Hakkında Raporların Değerlendirilmesi

        1.2.3.EARGED Ortaöğretim Fizik Dersi Öğretim Programı İhtiyaç Belirleme Analiz Raporu

        1.2.4. Dünya Ülkelerinde Fizik Dersi Öğretim Programları

    1.3. Fizik Dersi Öğretim Programı'nın Temel Yapısı

    1.4. Fizik Dersi Öğretim Programı'nın Temel Yaklaşımı

        1.4.1. Programın Öğrenme Yaklaşımı

1.4.2. Programın Ölçme ve Değerlendirme Yaklaşımı

2. Fizik Dersi Öğretim Programı'nın Öğrenme Alanları

2.1. Fizik Dersi Öğretim Programı'nda Beceri Kazanımları

2.1.1. Problem Çözme Becerileri (PÇB)

2.1.2. Fizik-Teknoloji-Toplum-Çevre (FTTÇ) Kazanımları

2.1.3. Bilişim ve İletişim Becerileri (BİB)

2.1.4. Tutum ve Değerler (TD)

2.2. Fizik Dersi Öğretim Programında Bilgi Kazanımları

3. Öğretmen ve Kitap Yazarlarından Beklentiler

4. Akademik Paylaşım

5. Fizik Öğretim Programında Yapılan Değişiklikler

6. 9. Sınıf Fizik Dersi Öğretim Programının Ünite Organizasyonu

A. Genel Bakış

B. Ünitenin Amacı

C. Kavramları Vermek İçin Kullanılabilecek Yaşamdan Örnekler (Bağlamlar)

D. Öğrenilecek Bilimsel Kavram ve Konular

E. Öğrenci Kazanımları

F. Kullanılan Sabitler, Formüller ve Birimler

Bağlam Birimi Olarak Alınmayacak Bölümler

Fizik Öğretim Programı 9. Sınıf Üniteleri ve Süreleri

Tablolarda Yer Alan Semboller

Örnek Öğretim ve Değerlendirme Etkinliği

B. Analiz Kuralları

İçerik analizi yapılırken dikkate alınması gereken kurallara aşağıda yer verilmiştir.

1. Analize başlamadan önce kod rehberini, kategorilere ve tanımlara hâkim oluncaya kadar okuyunuz ve dikkatlice inceleyiniz.

2. Analize başlamadan önce Ortaöğretim 9. Sınıf Fizik Dersi Öğretim Programını inceleyiniz.

3. Analizin amacına uygun olması için belirtilen kayıt birimlerini belirtilen bağlam birimleri çerçevesinde ele alınız.

4. Öğretim programı kodlanırken istenilen bağlamdan başlanabilir fakat kodlama işlemine getireceği kolaylık açısından baştan sona doğru ilerlenmesi tavsiye edilir. Öğretim programının baştan sonra okur gibi ilerlenmesi kodlamayı kolaylaştırdığı gibi analizin amacına uygun olmasına da katkı sağlayacaktır.

5. Kodlama işleminde zorluk çekildiği zaman aynı bağlam birimi içerisinde kalarak o ya da bir önce/sonraki sayfada yer alan bir önce/sonraki bölümlere gidilir.

6. Bir bağlam birimi birden çok kategoriyi barındırabilecekken, bir kayıt birimi sadece bir kategoriyle eşleştirilir.

7. Bir bölüm içerisinde bir kategoriye ait bir kod tekrarlanıyorsa, tekrarlanan kod sadece bir defa kodlanır.

8. Bir bölümde bilimsel süreç becerilerine ait herhangi bir kodlama yapılmıyorsa o bölüm NA olarak kodlanır.

9. Ortaöğretim 9. Sınıf Fizik Dersi Öğretim Programını kodlarken ilk 5 bölüm diğer bölümlere ihtiyaç duyulmaksızın kodlanabilir. Fakat 6. Bölüm olan 9. Sınıf Fizik Dersi Öğretim Programının Ünite Organizasyonu'ndaki üniteler kodlanırken önceki bölümlerden faydalanılır. Bu bölümdeki Öğrenci kazanımları kısmında yer alan kazanımlar kodlanırken, maddelerin sonunda parantez içinde yer verilen beceri kazanımları dikkate alınmalıdır. Bunun için her madde için belirtilen kazanımın bulunduğu ilgili sayfaya gidilerek o kazanım için yeniden kodlanmalıdır. Ayrıca, her kazanım için tabloda yer alan açıklamalar da kodlama yapılırken dikkate alınmalıdır.

APPENDIX D

SCIENCE PROCESS SKILLS OBSERVATION SHEET (SPSOS)

Gözlem Bilgileri

Okul: Sınıf /Şube:

Öğretmenin İsmi: Gözlem Yapılan Tarih:

Gözlem Yapılan Sınıf ve Şube: Başlama-Bitirme Saati:

Gözlem Yapılan Konu:

Gözlem Yapılan Dersin Kazanımı:

Saat	BSB Kodu	Açıklama

Saat	BSB Kodu	Açıklama

Bilimsel Süreç Becerileri Kodları

Gözlem yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	OKD1	Gözlem yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		OKD2	Bilim adamlarının gözlem yaptıklarını ifade eder.
		OKD3	Bilimde gözlemin önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	OKP1	Gözlem yapma becerisi hakkında bilgi verir, soru sorar.
		OKP2	Nasıl gözlem yapılması gerektiğini açıklar, soru sorar.
		OKP3	Gözlem yaparken dikkat edilmesi gerekenler hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	OSTP	Öğrenciye bir amaç belirtmeden gözlem yaptırır; öğrencinin sadece fiziksel olarak etkin olduğu fakat zihinsel olarak gözlemin amacını düşünmediği durumdur.
		OSTM	Öğrenciyi gözlem yapma becerisi; nasıl gözlem yapılması gerektiği hakkında düşündürür. Öğrenci fiziksel olarak bir gözlem yapmaz; fakat gözlem yapma becerisi hakkında düşünerek zihinsel olarak etkindir.
		OSTMP	Öğrenciye gözlem yaptırır. Nesnelerde meydana gelen değişimi duyularını kullanarak (görme, işitme, koklama, dokunma ve tat alma) belirlemesini ister. Öğrenciye belirli bir amaç doğrultusunda nitel gözlem yaptırır; Cisimlerin fiziksel özelliklerini, durumlarını, hareketlerini ve/veya bunlarda meydana gelen değişiklikleri betimlemesini ister.

Ölçüm yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	SKD1	Ölçüm yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		SKD2	Bilim adamlarının ölçümler yaptıklarını ifade eder.
		SKD3	Bilimde ölçmenin, ölçüm aracı kullanmanın önemini açıklar/ soru sorar.
		SKD4	Herhangi bir ölçümde kullanılan birim, birim dönüşümleri hakk. bilgi verir.
	İşlemsel Bilgi	SKP1	Ölçüm yapma becerisi hakkında bilgi verir, soru sorar.
		SKP2	Herhangi bir şeyin nasıl ölçüleceği hakkında bilgi verir, soru sorar.
		SKP3	Ölçüm yaparken dikkat edilmesi gerekenler hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	SSTP	Öğrenciye ölçüm yaptırır ve/veya ölçüm aracı yaptırır; öğrencinin sadece fiziksel olarak etkin olduğu fakat zihinsel olarak ölçüm yapma hakkında düşünmediği durumdur.
		SSTM	Öğrenciyi ölçüm yapma becerisi; nasıl ölçüm yapılması gerektiği hakkında düşündürür. Öğrenci fiziksel olarak bir ölçüm yapmaz; fakat ölçüm yapma becerisi hakkında düşünerek zihinsel olarak etkindir.
		SSTMP	Öğrenciden bir şeyi ölçmesini ve/veya ölçüm aracı geliştirmesini ister. Öğrenciden nicel betimleme yapmasını ister. SSTP den farklı olarak öğrenci bu durumda hem fiziksel hem de zihinsel olarak etkindir.

Çıkarım yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	IKD1	Çıkarım yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		IKD2	Bilim adamlarının çıkarımlarda bulunduklarını ifade eder.
		IKD3	Bilimde çıkarım yapmanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	IKP1	Çıkarım yapma becerisi hakkında bilgi verir, soru sorar.
		IKP2	Nasıl çıkarım yapılması gerektiğini açıklar, soru sorar.
		IKP3	Çıkarım yaparken dikkat edilmesi gerekenler hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	ISTP	Öğrenciye zihinsel bir süreç gerektirmeyecek şekilde çıkarım yaptırır. Bu durum kitapta öğrencinin çıkarım yapmasını istediği bölümün hemen ardından cevabın verildiği durumlar için kodlanabilir. Daha önce ifade edilmiş durumlar için de geçerlidir.
		ISTM	Öğrenciyi başka birisi(leri) tarafından yapılan bir çıkar hakkında düşündürür. Öğrenci çıkarım yapmaz, fakat yapılan çıkarım hakkında düşünerek nasıl yapılması gerektiği konusunda zihinsel olarak etkindir.
		ISTMP	Öğrenciden bir olayın nedenine dair açıklama yapmasını ister. Öğrencilerden bir olayın olası nedenleri hakkında verilere dayalı olarak tartışmalarını ister.

Tahmin etme kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	PKD1	Tahmin etmenin bilimsel süreç becerilerinde biri olduğunu ifade eder.
		PKD2	Bilim adamlarının çalışmalarında nesne ya da olaylar hakkında tahminlerde bulunduklarını ifade eder.
		PKD3	Bilimde tahmin etmenin önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	PKP1	Tahmin etme becerisi hakkında bilgi verir, soru sorar.
		PKP2	Verilere dayanarak nasıl tahmin yürütülebileceğini açıklar, soru sorar.
		PKP3	Bir olay hakkında tahmin yapılırken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	PSTM1	Öğrenciyi, toplanan verilere ya da yapılan gözlemlere dayanarak neler tahmin yürütülebileceği üzerine düşündürür.
		PSTM2	Öğrencinin gelecekteki bir olay, etkinlik ya da deneyin muhtemel sonuçları hakkında gözlem ve tecrübeye dayalı olarak tahminde bulunmasını ister.
		PSTM3	Öğrenciden, değişkenler arasındaki ilişkiden yararlanarak yeni bir değişkenin olası etkilerini önceden kestirmesini ister.

Sınıflandırma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	LKD1	Sınıflandırmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		LKD2	Bilim adamlarının çalışmalarında sınıflandırma yaptıklarını ifade eder.
		LKD3	Bilimde sınıflandırma yapmanın önemini açıklar ya da soru sorar.
		LKD4	Daha önce yapılmış bir sınıflandırma hakkında bilgi verir: sınıflandırma kriterleri, ve/veya sınıflandırmadaki ortak ve/veya farklı özellikler hakkında bilgi verir.
	İşlemsel Bilgi	LKP1	Sınıflandırma becerisi hakkında bilgi verir, soru sorar.
		LKP2	Sınıflandırmanın nasıl yapılması gerektiğini açıklar, soru sorar.
		LKP3	Sınıflandırma yaparken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	LSTM1	Nesne ya da olayların istenen ortak özelliklerini belirlemesi istenir. Nesne ya da olayların istenen farklı özelliklerini belirlemesi istenir.
		LSTM2	Nesne ya da olayları ilişkilerine göre düzenlemesi istenir. Verilen bilgiler doğrultusunda sınıflandırma yapması istenir. Bilinen bir sınıflandırmada grupların benzer özelliklerinin belirlenmesi/ ifade edilmesi/ tartışılması istenir. Bilinen bir sınıflandırmada grupları birbirinden ayıran özelliklerin ifade edilmesi/ belirlenmesi/ tartışılması istenir. Bilinen bir sınıflandırmada belirlenmiş olan parametre hakkında bilgi verir, soru sorar, düşündürür.
	Transfer Etme Becerileri	LSRM	Öğrencilerden kendisinin belirleyeceği kıstas(lar) doğrultusunda nesne ya da olayları sınıflandırması istenir.

Bilimsel iletişim kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	CKD1	Bilimsel iletişim kurmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		CKD2	Bilim adamlarının deney ve gözlemlerden elde etikleri verileri diğer bilim adamlarının incelemesi/ onaylaması /yeniden denemeleri için paylaştıklarını ifade eder.
		CKD3	Bilimsel verilerin paylaşılması, tartışılması, sorgulanması veya analiz edilmesinin bilimin ilerlemesi için gerekli olduğunu vurgular, düşündürür. Bilimsel bilginin oluşması ve yayılmasında iletişimin etkisini vurgular.
	İşlemsel Bilgi	CKP1	Bilimsel iletişim kurma becerisi hakkında bilgi verir, soru sorar.
		CKP2	Bilimsel iletişimin nasıl kurulması gerektiğini açıklar, soru sorar.
		CKP3	Bilimsel iletişim kurarken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	CSTP	Yazılı kaynaklardan yapılan araştırmanın başkaları ile paylaşılmasını ister. Öğrenci kendinden bir şey katmaz araştırmaya, var olan bilgiyi araştırır ve bulduklarını paylaşır.
		CSTM	Bilimsel iletişim kurma hakkında öğrenciyi düşündürür. Öğrenci fiziksel olarak bir sunum yapmaz ya da başkalarıyla tartışmaz ama yaptığı bilimsel çalışmayı başkalarına nasıl aktaracağı hakkında düşünür.
		CSTMP	Gözlem, elde edilen veriler, çıkarım ve/veya tahmin, hipotez, değişkenlerin nasıl kontrol edildiği, tasarlanan deneyler, ulaşılan sonuçlar, yapılan bir araştırma hakkında elde edilenlerin, düşünce ve/veya yorumların paylaşılmasını ister. Yapılan bilimsel bir çalışma; deney, gözlem vs. hakkında sunum yaptırır. Yapılan bir çalışma, deney, gözlem vs. hakkında rapor hazırlatır.

Hipotez kurma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	HKD1	Hipotez kurmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		HKD2	Bilim adamlarının çalışmalarında hipotez kurduklarını ifade eder, hipotezlerine yer verir.
		HKD3	Bilimde hipotez kurmanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	HKP1	Hipotezin ne olduğu ve/veya nasıl kurulduğunu anlatır, soru sorar.
		HKP2	Nasıl hipotez kurulması gerektiğini açıklar; iyi bir hipotezin özellikleri (rasyonel olmak, açık ve işlemsel olarak tanımlanabilir olmak, sınanabilir olmak) hakkında bilgi verir, soru sorar.
		HKP3	Hipotez kurarken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	HSTM1	Verilen ya da kendi oluşturduğu bir hipotezin, iyi bir hipotezde olması gereken özellikler bakımından değerlendirilmesini ister.
		HSTM2	Bir önermenin araştırılıp araştırılmayacağının belirlenmesini ister.
			Bir olayı ya da ilişkiyi açıklamak, deney ya da araştırma için test edilebilir bir hipotez kurulmasını ister.

Değişkenleri Belirleme ve Kontrol Etme

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	VKD1	Değişkenleri belirlemenin ve/veya kontrol etmenin bilimsel süreç becerilerinden biri olduğunu ifade eder.
		VKD2	Bilim adamlarının yaptıkları deneylerde aşağıdaki bilgilerden biri, bir kaçı ya da hepsine yer verir: Değişkenleri belirleyip, tanımladıklarına Deney süresince değişkenleri nasıl kontrol ettiklerine, Hangi değişkeni değiştirdikleri ve buna nasıl karar verdiklerine, Deney sonunda elde edilen bilgilerden nasıl sonuca ulaştıklarına.
		VKD3	Bilimde değişkenleri belirleme ve/veya kontrol etmenin önemini açıklar, soru sorar.
	İşlemsel Bilgi	VKP1	Değişkenlerin belir. ve/veya kontrol etme hakkında bilgi verir, soru sorar.
		VKP2	Değişkenlerin nasıl belirlenmesi ve/veya kontrol edilmesi gerektiğini açıklar, soru sorar.
		VKP3	Değişkenleri belirlerken ve/veya kontrol ederken dikkat edilmesi gereken hususlar hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	VSTP	Deney sırasında hangi değişkenlerin nasıl kontrol edileceğini söyleyerek öğrenciden yapmasını ister. Öğrenci fiziksel olarak etkindir fakat değişkenleri nasıl kontrol edeceği söylendiği için zihinsel olarak etkin değildir.
		VSTM1	Öğrenciden bir durum, olay ya da deney için değişkenleri belirlemesini, bağımsız, bağımlı ve kontrol edilmesi gereken değişkenleri belirlemesi istenir. Öğrenci sadece zihinsel olarak etkindir, önünde fiziksel bir ortam bulunmamaktadır değişkenleri manipüle etmek için.
		VSTM2	Öğrenciden kurgulanan bir deney, durum ya da olay için değişkenleri belirlemesi ve/veya tanımlaması istenir. Öğrenciden kurgulanan bir deney sırasında değişkenlerin nasıl kontrol edilebileceği üzerine düşünmesi istenir. Öğrenci fiziksel olarak etkin değildir fakat değişkenlerin kontrol edilmesi hakkında düşündüğü için zihinsel olarak etkindir.
		VSTMP	Bir durum, olay ya da deney için aşağıdaki maddelerinden en az birini, bir kaçını ya da hepsini yaptırır: Değişkenlerin belirlenmesi, tanımlanması, sabit tutulacak değişkenlerin belirlenmesi, bağımsız değişkenin belirlenmesi, bağımlı değişkenin belirlenmesi, kontrol edilemeyen değişkenlerin belirlenmesi, bağımsız değişkenin nasıl değiştirileceğine karar verilmesi, deney sonucunda iki değişken arasındaki ilişkinin ortaya konması, beklenmedik bir sonuca ulaştığında, neden beklendiği şekilde sonuçlanmadığını değişkenler üzerinden sorgulanması

Deney Tasarlama ve Yapma

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	EKD1	Deney yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		EKD2	Bilim insanlarının deney tasarladıklarını ve yaptıklarını ifade eder.
		EKD3	Bilimde deney tasarının ve yapmanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	EKP1	Deney yapma becerisi hakkında bilgi verir, soru sorar.
		EKP2	Nasıl deney tasarlanması ve/veya yapılması/ Deney malzemelerinin nasıl kullanılması gerektiğini açıklar, soru sorar.
		EKP3	Deney yaparken dikkat edilmesi gerekenler hakkında bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	ESTP	Öğrencilere adımları belirlenmiş bir deney, aşağıdaki koşulların hepsini sağlayacak şekilde yaptırılır; • Deneyin sonucunu tahmin edilmesi ya da hipotez kurulmasını ister • Deney düzeneğini öğrencinin kurmasını ister • Verileri öğrencinin kaydetmesini ister • Öğrencinin verileri yorumlamasını ister • Öğrencinin deneyde elde edilen sonuç doğrultusunda tahminin ya da hipotezin doğruluğuna karar vermesini ister
		ESTM	Öğrenciden fiziksel olarak deney yapmasını istemez, fakat bir hipotezi sınamak için nasıl bir deney düzeneği kurulması gerektiği hakkında düşündürür.
		ESTMP	Öğrenciden yapılacak bir deney için uygun araç gereçleri seçmesini ister/ Bir hipotezi sınamak, yapılan bir tahmini test etmek, değişkenler arasındaki ilişkiyi belirlemek ya da bir soruya cevap vermek amaçlarından herhangi biri için öğrencinin özgün bir deney (düzeneğinin) tasarlamasını ister.

Veri Toplama ve Yorumlama

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	DKD1	Veri toplamanın, verileri sistematik bir şekilde düzenlemenin, bilgilerden arındırmanın ve/veya yorumlamanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		DKD2	Bilim insanlarının düzenli bir biçimde verileri topladıkları, organize ettikleri ve/veya akla uygun bir şekilde yorumladıklarını ifade eder. Bilim adamlarının veri toplama ve yorumlama çalışmalarına ait detaylı örneğe yer verir *(Sadece 'şu verileri toplamıştır' gibi genel cümleler değil, verilerin nasıl toplandığı, nasıl organize edildiği, bu süreçte nelere dikkat edildiği gibi detaylı bilgilerin verildiği ifadelere yer verir)*
		DKD3	Bilimde veri toplamanın ve yorumlamanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	DKP1	Veri toplama ve yorumlama becerisi hakkında bilgi verir, soru sorar.
		DKP2	Nasıl veri toplanması ve/veya yorumlaması gerektiğini açıklar, soru sorar. Yapılan bir çalışmaya ait verilerin nasıl düzenlendiğiyle ilgili örnek verir.
		DKP3	Veri topl. sürecinde dikkat edilmesi gerekenler hk.da bilgi verir, soru sorar.
Beceri Boyutu	Görev Becerileri	DSTP	Öğrenciden veri toplanmasını ister: Öğrenciden yaptığı gözlemde elde ettiği verileri not etmesini ister, Öğrenciden değişkenlerle yaptığı denemelerle veri toplamasını ister.
		DSTM	Toplanan verilerin düzenlenmesini ister: Verilerin, deneyin sonucunu etkilemeyecek ve/veya karışıklığa yol açacak gereksiz bilgilerden arındırılmasını ister. Herhangi bir formda (düz yazı, grafik, tablo, sütunlu grafik vb. gibi) verilen verilerin başka bir forma (düz yazı, grafik, tablo, sütunlu grafik vb. gibi) dönüştürülmesini ister.
	Transfer Etme Becerileri	DSR1	Verilerin yorumlanmasını ister. Verileri yorumlarken görsel formlardan (grafik, tablo, sütunlu grafik vb. gibi) faydalanılmasını ister. Verilen bir görsel formu (grafik, tablo vb. gibi) yorumlamalarını ister. Yapılan tahminler ile deney/gözlemde elde edilen verilerle ulaşılan sonuçların karşılaştırılmasını ister. Verileri yorumlayarak bir sonuca ulaşılmasını ister.
		DSR2	Öğrencilerden elde edilen sonuçların genel uygulanabilirliği hakkında varsayımda bulunmasını ister.

Model Yapma

	Tür	Kod	Açıklama
Bilgi Boyutu	İfadesel Bilgi	MKD1	Model yapmanın bilimsel süreç becerilerinden biri olduğunu ifade eder.
		MKD2	Bilim adamlarının anlaşılması güç kavramların, nesne ve olayların modellerini yaparak anlaşılır hale getirdiklerini ifade eder. Bilim adamlarının yaptıkları modeller hakkında detaylı bilgi verir. (Modeli kimin geliştirdiği, gerçek halini nasıl algıladığı ve gerçeği ile modeli arasındaki benzerlik ve farklılıkları hakkında bilgi verir)
		MKD3	Bilimde model yapmanın önemini açıklar ya da soru sorar.
	İşlemsel Bilgi	MKP1	Model yapma becerisi hakkında bilgi verir: Verilen model ile gerçek nesne/olay arasındaki benzerlikleri vurgular, soru sorar.
		MKP2	Nasıl model yapılması gerektiğini açıklar. Olay, nesne ya da fikirleri açıklamak için -aşağıdaki koşulları sağlayarak- model kullanılır: • Anlatılanın gerçeğinin modeli olduğunu vurgular. • Gerçeği ile benzer ve farklılıkları hakkında bilgi verir.
		MKP3	Modelleme yapılırken nelere dikkat edilmesi gerektiğini ifade eder; Model yapabilmek için gerçeği hakkında mümkün olduğunca fazla veri toplamanın önemli olduğunu ifade eder, soru sorar.
Beceri Boyutu	Görev Becerileri	MSTP	Öğrenciden daha önce yapılmış bir modeli yapmasını ister.
		MSTM	Öğrencinin model ile gerçeği (nesne, olay, kavram, sistem vb.) arasındaki benzerliklerin ve/veya farklılıkları bulmasını ister.
		MSTMP	Daha önce yapılmış bir modeli kullanarak olaylar ya da kavramlar arasındaki ilişkinin açıklanmasını ister. Herhangi bir formda (örn: üç boyutlu nesne) olan nesneyi temsil edecek ya da açıklayacak başka bir forma (örn: iki boyutlu bir çizim) dönüştürülmesini ister. Yeni bir kavram/ olay için özgün bir modelin geliştirilmesini ister.

APPENDIX E

SCIENCE PROCESS SKILLS QUESTIONNAIRE (SPSQ)

Sayın Öğretmenim,

Bu anketin amacı 9. Sınıf Fizik Dersi Programının uygulanmasında fizik öğretmenlerinin bilimsel süreç becerilerine ne sıklıkla yer verdiğini belirlemektir. Anket ile elde edilen veriler Enerji Ünitesi boyunca gözlem yapılacak sınıfları belirlemek için kullanılacaktır. Anketteki soruları eksiksiz bir şekilde cevaplandırmanız çalışma için büyük önem taşımaktadır. Bu anketle toplanılan kişisel bilgiler kesinlikle gizli tutulacaktır. Anket üç bölümden oluşmaktadır; (A) Kişisel Bilgiler, (B) Enerji Ünitesi Hakkında Mesleki Bilgiler, (C) Sınıf İçi Bilimsel Süreç Becerileri Anketi.

Çalışmaya verdiğiniz yardım ve katkılarınız için teşekkür ederim.

Araş. Gör. Beril YILMAZ SENEM

ODTÜ, Eğitim Fakültesi, OFMAE

A. Kişisel Bilgiler

Adınız Soyadınız/ Yaşınız		
Öğrenim durumunuz	( ) Üniversite ( ) Yüksek Lisans ( ) Doktora	
Mezun olduğunuz fakülte	( ) Eğitim F. ( ) Fen ve Edebiyat F. ( ) Mühendislik F.	
Mezun olduğunuz üniversite/bölüm	/	
Çalıştığınız okul/ Okul türü	/	
Daha önceki yıllarda çalıştığınız okullar, görev yaptığınız süre		

B. Enerji Ünitesi Hakkında Mesleki Bilgiler

1. Kaç yıldır fizik dersi veriyorsunuz? (______)

2. Enerji Ünitesini bu programdaki içeriği ile kaç yıldır veriyorsunuz? (______)

3. Enerji Ünitesini bu programdaki içeriği ile kaç defa verdiniz? (______)

   (Açıklama: Bir öğretim yılında birden fazla sınıfta -3 farklı sınıfta- enerji ünitesini anlattıysanız, o yıl için enerji ünitesini 3 defa anlatmış olursunuz)

4. Yeni öğretim programı hakkında herhangi bir eğitim/seminer aldınız mı?

   ( ) Evet - ( ) Hayır

   4a. Cevabınız 'Evet' ise, lütfen almış olduğunuz eğitim/seminer için aşağıdaki tabloyu doldurunuz.

Eğitim/Semineri Düzenleyen Kurum ya da Kuruluş	Eğitim / Seminer Yeri	Eğitim / Seminer Tarihi	Eğitim / Seminer Süresi	Eğitim/Seminer Sonunda Almış Olduğunuz Unvan

5. Dokuzuncu sınıflarda Enerji Ünitesi'ni işlerken öğretim programında belirtilen süre yeterli geliyor mu? ( ) Evet - ( ) Hayır

6. Dönemde kaç ders saati fizik laboratuvarında ders işliyorsunuz? (________)

7. Enerji Ünitesinde kaç ders saati fizik laboratuvarında ders işliyorsunuz? (________)

8. Dersliğinizde fizik ders araç gereçleri bulunuyor mu? ( ) Evet - ( ) Hayır

   8a. Cevabınız 'Evet' ise, bu araç gereçleri Enerji Ünitesini işlerken ne sıklıkta kullanıyorsunuz? (________)

9. Dokuzuncu sınıf fizik ders kitabını nasıl kullanıyor musunuz? (Örneğin derste öğrencilere okutuyorum, belirli bölümleri okutuyorum, öğrencilere evde okumalarını söylüyorum, ödev veriyorum, vb. gibi)

10. Derste kullandığınız veya öğrencilerinize önerdiğiniz yardımcı kaynak kitapları nasıl kullanıyorsunuz? (Örneğin derste öğrencilere okutuyorum, belirli bölümleri okutuyorum, öğrencilere evde okumalarını söylüyorum, ödev veriyorum, vb. gibi)

C. Sınıf İçi Bilimsel Süreç Becerileri Anketi

Aşağıdaki tabloda sol sütunda bilimsel süreç becerilerini içeren eğitim-öğretim etkinliklerine yer verilmiştir. Fizik dersinde Enerji Ünitesini işlerken bu etkinliklere ne sıklıkta yer veriyorsunuz? Aşağıdaki tabloda yer alan her ifadenin karşısında o madde için en uygun olduğunu düşündüğünüz kutucuğa çarpı işareti (X) koyarak işaretleyiniz.

NOT: Lütfen her madde için yalnızca bir işaretleme yapınız.

Fizik dersimde, Enerji Ünitesi'ni işlerken		Hangi sıklıkta yaparsınız?			
		Asla	Nadiren	Bazen	Sık Sık
Gözlem Yapma	1. Bilimde, gözlem yapmanın önemini açıklarım.				
	2. Gözlem yapma becerisi hakkında bilgi veririm.				
	3. Öğrencilerimin nesne ya da olaylardaki değişimi gözlemlemelerini sağlarım.				
	4. Öğrencilerime dokunma, duyma, görme, koklama, tat alma deneyimlerinden faydalanarak gözlem yaptırırım.				
Ölçüm Yapma	5. Bilimde, ölçüm yapmanın ölçüm aracı kullanmanın önemini açıklarım.				
	6. Ölçüm yapma becerisi hakkında bilgi veririm; neler dikkat edilmesi gerektiği hakkında bilgi veririm.				
	7. Öğrencilerimden bir büyüklüğü ölçmelerini isterim.				
Çıkarım Yapma	8. Bilimde, çıkarım yapmanın önemini açıklarım.				
	9. Çıkarım yapma becerisi hakkında bilgi veririm.				
	10. Öğrencilerimden fiziksel bir olayın nedenine dair açıklama yapmalarını isterim.				
Sınıflandırma	11. Bilimde, sınıflandırma yapmanın önemini açıklarım.				
	12. Sınıflandırma becerisi hakkında bilgi veririm.				
	13. Öğrencilerimin nesne ya da olayları sınıflandırmalarını sağlarım.				
Tahmin Etme	14. Bilimde, tahmin etmenin önemini açıklarım.				
	15. Tahmin etme becerisi hakkında bilgi veririm.				
	16. Öğrencilerimin gerçekleşmemiş bir olay, etkinlik ya da deneyin olası sonuçları hakkında gözlem ve tecrübelerine dayalı olarak tahminde bulunmalarını sağlarım.				

Fizik dersimde, Enerji Ünitesi'ni işlerken		Hangi sıklıkta yaparsınız?			
		Asla	Nadiren	Bazen	Sık Sık
Bilimsel İletişim Kurma	17. Bilimde, bilimsel iletişim kurmanın önemini açıklarım.				
	18. Bilimsel iletişim kurma becerisi hakkında bilgi veririm.				
	19. Öğrencilerimin yaptıkları çalışmaları birbirlerine aktarmalarını, birlikte tartışmalarını sağlarım.				
Hipotez Kurma	20. Bilimde hipotez kurmanın önemini açıklarım.				
	21. Hipotez kurma becerisi hakkında bilgi veririm.				
	22. Öğrencilerimin bir olayı açıklamaları ya da deney yapmak için test edilebilir bir hipotez kurmalarını sağlarım.				
Değişkenleri Belirleme ve Kontrol Etme	23. Bilimde değişkenleri belirlemenin ve kontrol etmenin önemini açıklarım.				
	24. Değişkenleri belirleme ve kontrol etme becerisi hakkında bilgi veririm.				
	25. Deney yaparken ya da hakkında tartışırken öğrencilerimden bağımlı, bağımsız değişkenleri belirlemesini isterim.				
	26. Deneyde öğrencilerimden değişkenleri kontrol etmelerini sağlarım.				
Deney Yapma ve Tasarlama	27. Bilimde deney yapma ve tasarlamanın önemini vurgularım.				
	28. Deney yapma ve tasarlama becerisi hakkında bilgi veririm.				
	29. Öğrencilerimin basamakları verilmiş bir deneyi yapmalarını sağlarım.				
	30. Öğrencilerimden bir hipotezi sınamak için deney düzeneği tasarlamalarını isterim.				
Veri Toplama ve Yorumlama	31. Bilimde veri toplama ve yorumlanın önemini vurgularım.				
	32. Veri toplama ve yorumlama becerisi hakkında bilgi veririm.				
	33. Öğrencilerimin yaptıkları gözlem ya da ölçümlerle veri toplamalarını sağlarım.				
	34. Öğrencilerimden topladıkları verileri düzenlemelerini isterim.				
	35. Öğrencilerimin kendi topladıkları verileri ya da benim verdiğim hazır verileri yorumlamalarını sağlarım.				

Fizik dersimde, Enerji Ünitesi'ni işlerken		Hangi sıklıkta yaparsınız?			
		Asla	Nadiren	Bazen	Sık Sık
Model Yapma	36. Bilimde model yapmanın önemini vurgularım.				
	37. Model yapma becerisi hakkında bilgi veririm.				
	38. Öğrencilerimin geliştirilmiş bir model ile gerçeği arasında ilişki kurmasını sağlarım.				
	39. Öğrencilerimden fiziksel bir kavram ya da olay için özgün model geliştirmelerini isterim.				

APPENDIX F

RESULT OF PHYSICS LESSONS' OBSERVATION IN THE FIRST STAGE

	Teachers									
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Observation duration	4 hours	3 hours	3 hours	5 hours	4 hours	3 hours	3 hours	4 hours	4 hours	2 hours
Meas.	3	5	12	7	3	1	2	5	0	0
(KB-SK)	(3-0)	(1-4)	(2-10)	(7-0)	(1-2)	(1-0)	(2-0)	(5-0)	(0-0)	(0-0)
Col.Int.D.	0	8	6	0	11	3	1	1	2	0
(KB-SK)	(0-0)	(0-8)	(0-6)	(0-0)	(0-11)	(0-3)	(0-1)	(0-1)	(0-2)	(0-0)
Exper.	0	0	1	0	0	0	4	0	0	0
(KB-SK)	(0-0)	(0-0)	(1-0)	(0-0)	(0-0)	(0-0)	(2-2)	(0-0)	(0-0)	(0-0)
Dfn.Cnt.V.	1	1	3	0	1	1	3	1	0	0
(KB-SK)	(0-1)	(0-1)	(0-3)	(0-0)	(0-1)	(0-1)	(1-2)	(0-1)	(0-0)	(0-0)
Model.	14	8	6	19	10	1	5	7	9	14
(KB-SK)	(0-14)	(0-8)	(0-6)	(0-19)	(0-10)	(0-1)	(0-5)	(0-7)	(0-9)	(0-14)
Infer.	0	1	1	0	0	0	4	0	1	0
(KB-SK)	(0-0)	(0-1)	(0-1)	(0-0)	(0-0)	(0-0)	(0-4)	(0-0)	(0-1)	(0-0)
Class.	1	5	4	1	1	1	1	1	0	1
(KB-SK)	(1-0)	(0-5)	(0-4)	(0-1)	(0-1)	(0-1)	(1-0)	(0-1)	(0-0)	(0-1)
Obser.	1	2	5	2	16	3	2	14	0	0
(KB-SK)	(0-1)	(0-2)	(0-5)	(0-2)	(2-14)	(0-3)	(0-2)	(0-14)	(0-0)	(0-0)
Hypot.	0	0	0	0	0	0	0	0	0	0
(KB-SK)	(0-0)	(0-0)	(0-0)	(0-0)	(0-0)	(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
Pred.	0	0	3	0	3	0	0	0	0	0
(KB-SK)	(0-0)	(0-0)	(0-3)	(0-0)	(0-3)	(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
Sci.Com.	0	2	3	0	2	0	0	0	0	0
(KB-SK)	(0-0)	(1-1)	(0-3)	(0-0)	(0-2)	(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
Total SPS	20	32	44	29	47	10	22	29	12	15
SPS/hour	5	10,67	14,67	5,8	11,75	3,333	7,333	7,25	3	7,5

APPENDIX G

RESULT OF SCIENCE PROCESS SKILLS QUESTIONNAIRE

Statements in the Questionnaire	Teachers									
	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T1 0
1. I explain importance of observing in science	3	3	4	2	4	3	3	4	2	3
2. I give information about observing skill	3	3	3	2	3	4	3	4	2	4
3. I make students observe changes of objects or events	3	3	4	3	4	3	2	3	3	3
4. I ask students make observations by using their senses (visual sense, touching, hearing, tasting, smelling)	3	4	4	3	4	3	3	2	2	3
5. I explain importance of making measurements and using measurement tools in science	3	3	4	3	3	3	3	4	3	3
6. I give information about measuring skill; aspects that should be considered during making measurements	3	3	4	3	3	4	3	3	3	3
7. I ask students measure a quantity	3	3	3	3	2	3	3	2	2	3
8. I explain importance of inferring in science	3	3	4	4	4	3	3	1	3	2
9. I give information about inferring skill	3	3	3	3	4	3	3	1	3	2
10. I ask students make inferences about reason of an event	4	4	4	4	4	4	4	1	4	4
11. I explain importance of classifying in science	3	3	4	3	2	3	3	3	3	3
12. I give information about classifying skill	3	3	4	3	2	3	3	3	3	4
13. I make students classify objects or events.	3	3	3	3	3	3	3	2	4	3
14. I explain importance of predicting in science	3	3	4	3	4	3	3	3	3	3
15. I give information about predicting skill	3	3	4	3	4	4	3	3	3	4
16. I make students predict about possible results of an occurred event, activity or experiment	4	3	3	4	4	4	3	2	3	4
17. I explain importance of scientific communication in science	3	3	4	3	4	3	3	4	3	3
18. I give information about scientific communication skill	3	3	4	3	4	3	3	3	3	4
19. I make students share their studies with each other	3	4	4	3	4	3	2	2	4	3
20. I explain importance of hypothesizing in science	3	3	4	3	3	3	3	3	3	3
21. I give information about hypothesizing skill	3	4	4	3	3	3	3	3	3	3

Statements in the Questionnaire	Teachers									
	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T10
23. I explain importance of def.-control. variables in science	3	3	4	3	3	3	3	3	3	3
24. I give information about defining-controlling variables skills	3	3	4	3	3	4	3	3	3	4
25. I ask students define dependent and independent variables while making or discussing about an experiment	2	3	3	2	2	2	2	1	3	2
26. I make students control variables during experiments	2	3	4	2	2	2	2	1	3	2
27. I explain importance of experimenting in science	3	3	4	3	4	3	3	4	3	3
28. I give information about skill of experimenting	3	3	4	3	4	4	3	3	3	4
29. I ask students make structured experiments	2	3	4	2	1	2	2	2	3	2
30. I ask students design an experiment setup to test a hypothesis	3	3	4	3	3	3	1	1	3	3
31. I explain importance of collecting-interpreting data in science	3	3	4	3	4	3	3	4	3	3
32. I give information about collecting-interpreting data skills	3	3	3	4	4	4	3	4	3	3
33. I make students collect data by observing or measuring	3	3	4	3	4	3	3	2	3	3
34. I ask students arrange the collected data	3	3	4	4	3	3	3	2	3	3
35. I ask students interpret data which they collect or I supply	3	3	4	3	4	3	3	2	4	3
36. I explain importance of modeling in science	3	4	4	3	3	4	3	3	3	3
37. I give information about skill of modeling	3	4	4	3	2	3	3	3	3	3
38. I ask students make relations between a model and its original	3	4	3	3	3	3	3	2	3	3
39. I ask students make a model of physical concept or an event.	3	4	3	3	3	3	1	1	3	3
Average frequency value	3	3	4	3	3	3	3	3	3	3

(1:Rarely, 2: Occasionally, 3: Periodically, 4: Usually)

APPENDIX H

INTERVIEW SHEETS

T2, 7 ders saati; 19.02.2013- 12.03.2013 tarihleri arasında gözlem yapılmıştır.

Gözlem sonuçlarım: Derste en çok yer verilen bilimsel süreç becerileri; modelleme, veri toplama ve yorumlama, sınıflandırma, bilimsel iletişim kurma, ölçme, gözlem yapma ve hipotez kurma. Bunun yanında çıkarım yapma, değişkenleri belirleme, deney yapma becerilerine sınırlı yer verilirken, tahmin etme becerisine hiç yer verilmemiştir.

Bilgi seviyesi

Hakkında bilgi verilen beceriler	Modelleme, Ölçme, Bilimsel iletişim kurma
Hakkında bilgi verilmeyen beceriler	Gözlem yapma, Çıkarım yapma, Veri toplama ve yorumlama, Sınıflandırma, Hipotez kurma, Değişkenleri belirleme, Deney yapma, Tahmin etme

Beceri seviyesi

Çok yer verilen beceriler;	Modelleme, Veri toplama ve yorumlama, Sınıflandırma,
Az yer verilen beceriler;	Gözlem yapma, Bilimsel iletişim kurma, Hipotez kurma, Çıkarım yapma, Değişkenleri belirleme, Deney yapma
Hiç yer verilmeyen beceriler;	Tahmin etme, Ölçme

Dersinizdeki gözlemlerime dayalı olarak varmış olduğum bu sonuç size anlamlı geliyor mu?

Detaylar;

Bilimsel İletişim kurma: bilimsel iletişim kurmanın öneminden bahsediyorsunuz ve vurguluyorsunuz.

Ölçme: neyin nasıl ölçüleceği hakkında birimler hakkında bilgi veriyorsunuz, fakat öğrenciler derste hiçbir şey ölçmüyorlar. Katılıyor musunuz?

Model yapma becerisi: Becerileri teker teker ele alırsak, modelleme becerisi dersinizde, matematiksel ifadeleri yerinde kullanma ve formüller yardımıyla değişkenler arasındaki ilişkiyi açıklama şeklinde karşımıza çıkıyor. Enerji ünitesinde kullanılan bağıntılar ve bu bağıntılar doğrultusundan çözülen problemler dersinizde önemli bir yer tutmaktadır. Gözlemlerim ışığında, enerji ünitesinde verdiğiniz yeni durumlar için öğrencilerin formülleri irdeleyerek ulaşacakları sonuçları yorumlamalarını sağladığınız sonucuna ulaştım. Örneğin değişik yüksekliklerde ilerleyen bir yolda hareket eden bir cismin nereye kadar çıkacağını soruyorsunuz öğrencilerinize. Öğrencilerin soruya doğru cevap verebilmeleri için cismin belirli aralıklardaki hareketini yorumlaması gerekir. Bunu da kinetik enerji, potansiyel enerji bağıntıları ve enerji korunumu ilkesini irdeleyerek, bu durum için yorumlayarak yapabilir. Dersinizde matematiksel model olan formüller direk olarak verilip sayısal değerler yerlerine konarak sayısal ifadelere ulaşılmıyor; formüller hem kendi içlerinde hem de birbirleri ile karşılaştırılarak yorumlanıyor. Katılıyor musunuz?

Bunun yanında modelleme becerisi hakkında bilgi seviyesinde bir paylaşım; formüllerin matematiksel bir model olduğuna dair bir açıklama, model yapmanın bilimdeki önemi ve benzeri gibi paylaşımlar, derslerinizde gözlenmemiştir, katılıyor musunuz?

Veri toplama ve yorumlama: Dersinizde en çok yer verilen bilimsel süreç becerileri arasında veri toplama ve yorumlama becerisi de bulunmaktadır. Öğrencilerin sınıf içinde yaptırdığınız gözlemleri ya da konu hakkında verdiğiniz yeni durumları yorumluyorlar. Katılıyor musunuz?

Sınıflandırma: Enerji ünitesinde yer alan farklı enerji kaynakları konusunda öğrenciler sınıflandırma yaparak, var olan bir sınıflandırmanın ortak ve farklı özelliklerini tartışarak sınıflandırma becerilerini geliştirmektedirler. Ya da bilinen bir sınıflandırmada verilen bilgiler doğrultusunda yeni bir örneği bir kategoriye yerleştirmesi istenmektedir. Katılıyor musunuz?

Bilimsel iletişim kurma: öğrenciler kitaptaki bazı etkinlikleri evde yapıp sınıfta sundular. Böylece öğrencilerin iletişim becerileri gelişmektedir. Fakat yapılan sunumlarda sadece etkinlikte yapılanlarla sınırlı kaldı, yaptıkları bir deneyi, bilimsel bir çalışmayı anlatmadılar. Katılıyor musunuz?

Gözlem yapma: derste iş konusunu daha iyi anlamaları için verdiğiniz farklı durumları sorduğunuz sorular doğrultusunda nesne ya da olaylardaki değişimleri gözlemlediler. Fakat deneysel anlamda bir gözle yapmadılar. Katılıyor musunuz?

Hipotez kurma: öğrenciler verilen sorunlara çözüm önerilerinde bulunuyorlar, fakat yaptıkları şeyin hipotez kurmak olduğunun farkında değiller. Katılıyor musunuz?

T3, 11 ders saati; 20.02.2013- 27.03.2013 tarihleri arasında gözlem yapılmıştır.

Gözlem sonuçlarım: Derste en çok yer verilen bilimsel süreç becerileri; modelleme, ölçme, sınıflandırma, bilimsel iletişim kurma, ver toplama ve yorumlama becerileri. Bunun yanında gözlem yapma, tahmin etme, değişkenleri belirleme ve kontrol etme, çıkarım yapma becerilerine sınırlı yer verilirken deney yapma ve hipotez kurma becerilerine hiç yer verilmemiştir.

Bilgi seviyesi

Hakkında bilgi verilen beceriler	Sınıflandırma, Ölçme, Veri toplama ve yorumlama, Deney yapma
Hakkında bilgi verilmeyen beceriler	Modelleme, Bilimsel iletişim kurma, Gözlem yapma, Hipotez kurma, Çıkarım yapma, Değişkenleri belirleme, Tahmin etme

Beceri seviyesi

Çok yer verilen beceriler;	Modelleme, Ölçme, Sınıflandırma, Bilimsel iletişim kurma, Veri toplama ve yorumlama, ,
Az yer verilen beceriler;	Gözlem yapma, Çıkarım yapma, Değişkenleri belirleme, Tahmin etme
Hiç yer verilmeyen beceriler;	Hipotez kurma, Deney yapma,

Dersinizdeki gözlemlerime dayalı olarak varmış olduğum bu sonuç size anlamlı geliyor mu?

Detaylar;

Model yapma becerisi: Becerileri teker teker ele alırsak, modelleme becerisi dersinizde, matematiksel ifadeleri yerinde kullanma ve formüller yardımıyla değişkenler arasındaki ilişkiyi açıklama şeklinde karşımıza çıkıyor. Enerji ünitesinde kullanılan bağıntılar ve bu bağıntılar doğrultusundan çözülen problemler dersinizde önemli bir yer tutmaktadır. Gözlemlerim ışığında, enerji ünitesinde verdiğiniz yeni durumlar için öğrencilerin formülleri irdeleyerek ulaşacakları sonuçları yorumlamalarını sağladığınız sonucuna ulaştım. Dersinizde matematiksel model olan formüller direk olarak verilip sayısal değerler yerlerine konarak sayısal ifadelere ulaşılmıyor; formüller hem kendi içlerinde hem de birbirleri ile karşılaştırılarak yorumlanıyor. Katılıyor musunuz?

Bunun yanında modelleme becerisi hakkında bilgi seviyesinde bir paylaşım; formüllerin matematiksel bir model olduğuna dair bir açıklama, model yapmanın bilimdeki önemi ve benzeri gibi paylaşımlar, derslerinizde gözlenmemiştir, katılıyor musunuz?

Ölçme: ölçme becerisinde en çok vurgulanan şey birimler. Bir büyüklüğün hangi birim ile ifade edildiği ve büyüklük yazılırken birim yazmanın önemi vurgulanmıştır. Bunun dışında yapılan ölçümler kitaptaki etkinliklerde yer alan ölçüm işlemleriydi. Bunun dışında başka bir şeyin ölçüldüğü gözlenmemiştir. Katılıyor musunuz?

Sınıflandırma: Enerji ünitesinde yer alan farklı enerji kaynakları konusunda öğrenciler sınıflandırma yaparak, var olan bir sınıflandırmanın ortak ve farklı özelliklerini tartışarak sınıflandırma becerilerini geliştirmektedirler. Ya da bilinen bir sınıflandırmada verilen bilgiler doğrultusunda yeni bir örneği bir kategoriye yerleştirmesi istenmektedir. Katılıyor musunuz?

Bilimsel iletişim kurma: öğrenciler araştırma konuları doğrultusunda ve ünitenin başlangıcında sorumlu oldukları etkinlikleri diğer öğrencilere sunum yaparak paylaşıyorlar. Böylece öğrencilerin iletişim becerileri gelişmektedir. Fakat yapılan bazı sunumlarda sadece internetten ya da yazılı kaynaklardan alınan bilgiler paylaşılmaktadır. Bunun yanı sıra bu paylaşımlar kitaptaki etkinliklerle sınırlıdır. Katılıyor musunuz?

Veri toplama ve yorumlama: Dersinizde en çok yer verilen bilimsel süreç becerileri arasında veri toplama ve yorumlama becerisi de bulunmaktadır. Öğrenciler araştırma konuları doğrultusunda internetten ya da yazılı kaynaklardan veriler toplayarak amaçları doğrultusunda ulaştıkları verileri düzenliyorlar. Öğrenciler bilimsel bilgiyi, günlük bilgiden arındırıyor ve gerekli olan bilgiyi gereksiz bilgilerden temizliyorlar. Bunun yanında matematiksel modelleri; formülleri kullanarak verileri yorumluyorlar. Bunun için zaman zaman sözlü ya da yazılı ifadeleri grafiğe dönüştürüyorlar. Bunun yanında, sunum yapılırken siz öğrencilere bir takım sorular sorarak elde ettikleri ve sundukları bilgileri yorumlamalarına teşvik ediyorsunuz. Ayrıca etkinliklerde sorulan soruları cevaplarken yine verileri yorumluyorlar. Katılıyor musunuz?

Gözlem yapma: derste yer verilen etkinliklerin çoğunda öğrenciler sorulan soru veya bir amaç doğrultusunda nesne ya da olaylardaki değişimleri gözlemlemekteler. Katılıyor musunuz?

Tahmin etme: Bir etkinlikte herhangi bir değişken değiştirildiğinde öğrenciden ne olacağına dair tahminde bulunması isteniyor.

Çıkarım yapma: yapılan/yapılmış bir gözlemin nedeni öğrencilere sorulmuştur.

T5, 10 ders saati; 27.03.2013- 19.04.2013 tarihleri arasında gözlem yapılmıştır.

Gözlem sonuçlarım: Derste en çok yer verilen bilimsel süreç becerileri; modelleme, veri toplama ve yorumlama, sınıflandırma, bilimsel iletişim kurma, ölçme, gözlem yapma ve hipotez kurma. Bunun yanında çıkarım yapma, değişkenleri belirleme, deney yapma becerilerine sınırlı yer verilirken, tahmin etme becerisine hiç yer verilmemiştir.

Bilgi seviyesi

Hakkında bilgi verilen beceriler	Sınıflandırma, Ölçme
Hakkında bilgi verilmeyen beceriler	Modelleme, Veri toplama ve yorumlama, Bilimsel iletişim kurma, Gözlem yapma, Hipotez kurma, Çıkarım yapma, Değişkenleri belirleme, Deney yapma, Tahmin etme

Beceri seviyesi

Çok yer verilen beceriler;	Modelleme, Veri toplama ve yorumlama, Sınıflandırma, Bilimsel iletişim kurma, Gözlem yapma
Az yer verilen beceriler;	Hipotez kurma, Çıkarım yapma, Ölçme, Değişkenleri belirleme, Deney yapma
Hiç yer verilmeyen beceriler;	Tahmin etme

Dersinizdeki gözlemlerime dayalı olarak varmış olduğum bu sonuç size anlamlı geliyor mu?

Detaylar;

Model yapma becerisi: Becerileri teker teker ele alırsak, modelleme becerisi dersinizde, matematiksel ifadeleri yerinde kullanma ve formüller yardımıyla değişkenler arasındaki ilişkiyi açıklama şeklinde karşımıza çıkıyor. Enerji ünitesinde kullanılan bağıntılar ve bu bağıntılar doğrultusundan çözülen problemler dersinizde önemli bir yer tutmaktadır. Gözlemlerim ışığında, enerji ünitesinde verdiğiniz yeni durumlar için öğrencilerin formülleri irdeleyerek ulaşacakları sonuçları yorumlamalarını sağladığınız sonucuna ulaştım. Örneğin değişik yüksekliklerde ilerleyen bir yolda hareket eden bir cismin nereye kadar çıkacağını soruyorsunuz öğrencilerinize. Öğrencilerin soruya doğru cevap verebilmeleri için cismin belirli aralıklardaki hareketini yorumlaması gerekir. Bunu da kinetik enerji, potansiyel enerji bağıntıları ve enerji korunumu ilkesini irdeleyerek, bu durum için yorumlayarak yapabilir. Dersinizde matematiksel model olan formüller direk olarak verilip sayısal değerler yerlerine konarak sayısal ifadelere ulaşılmıyor; formüller hem kendi içlerinde hem de birbirleri ile karşılaştırılarak yorumlanıyor. Katılıyor musunuz?

Bunun yanında modelleme becerisi hakkında bilgi seviyesinde bir paylaşım; formüllerin matematiksel bir model olduğuna dair bir açıklama, model yapmanın bilimdeki önemi ve benzeri gibi paylaşımlar, derslerinizde gözlenmemiştir, katılıyor musunuz?

Veri toplama ve yorumlama: Dersinizde en çok yer verilen bilimsel süreç becerileri arasında veri toplama ve yorumlama becerisi de bulunmaktadır. Öğrenciler araştırma konuları doğrultusunda internetten ya da yazılı kaynaklardan veriler toplayarak amaçları doğrultusunda ulaştıkları verileri düzenliyorlar. Öğrenciler bilimsel bilgiyi, günlük bilgiden arındırıyor ve gerekli olan bilgiyi gereksiz bilgilerden temizliyorlar. Bunun yanında matematiksel modelleri; formülleri kullanarak verileri yorumluyorlar. Bunun için zaman zaman sözlü ya da yazılı ifadeleri grafiğe dönüştürüyorlar. Bunun yanında, sunum yapılırken siz öğrencilere bir takım sorular sorarak elde ettikleri ve sundukları bilgileri yorumlamalarına teşvik ediyorsunuz. Katılıyor musunuz?

Sınıflandırma: Enerji ünitesinde yer alan farklı enerji kaynakları konusunda öğrenciler sınıflandırma yaparak, var olan bir sınıflandırmanın ortak ve farklı özelliklerini tartışarak sınıflandırma becerilerini geliştirmektedirler. Ya da bilinen bir sınıflandırmada verilen bilgiler doğrultusunda yeni bir örneği bir kategoriye yerleştirmesi istenmektedir. Katılıyor musunuz?

Bilimsel iletişim kurma: öğrenciler araştırma konuları doğrultusunda elde ettikleri verileri diğer öğrencilere sunum yaparak paylaşıyorlar. Böylece öğrencilerin iletişim becerileri gelişmektedir. Fakat yapılan sunumlarda sadece internetten ya da yazılı kaynaklardan alınan bilgiler paylaşılmaktadır. Öğrenciler yaptıkları bir deneyi, bilimsel bir çalışmayı anlatmamaktalar. Katılıyor musunuz?

Gözlem yapma: derste yer verilen etkinliklerin çoğunda öğrenciler sorulan soru veya bir amaç doğrultusunda nesne ya da olaylardaki değişimleri gözlemlemekteler. Katılıyor musunuz?

Ölçme: ölçme becerisinde en çok vurgulanan şey birimler. Bir büyüklüğün hangi birim ile ifade edildiği ve büyüklük yazılırken birim yazmanın önemi vurgulanmıştır. Bunun dışında sadece bir etkinlikte öğrencilerin ölçüm yapması istenmiştir.

Çıkarım yapma: yapılan/yapılmış bir gözlemin nedeni öğrencilere sorulmuştur.

Hipotez kurma: öğrenciler verilen sorunlara çözüm önerilerinde bulunuyorlar, fakat yaptıkları şeyin hipotez kurmak olduğunun farkında değiller. Katılıyor musunuz?

APPENDIX I

SCIENCE PROCESS SKILLS KEYWORDS

Name of skill	Definition	Key Words
Observing	Using the senses to collect information about objects and events	Observe, define, watch, monitor, view, examine, smell, taste, touch, listen, look, see, note, notice, describe
Measuring	Measuring properties of objects by using appropriate units and appropriate measuring instruments	Measure, determine, quantify, calculate, compute, estimate
Inferring	Making statements about an observation that provide a reasonable explanation.	Infer, explain, reason, suppose, clarify, describe, make clear
Classifying	Sorting or ordering objects or ideas into groups or categories based on their properties.	Sort, order, classify, categorize, class, organize, put in order, catalog, group, compare, contrast, show similarities and differences, class, type
Predicting	Guessing what the outcome of an event will be based on observations and, usually, prior knowledge of similar events.	Guess, predict, expect, imagine, foretell, see coming, suppose, tell, what if
Scientific Communicating	Transmit information learned from science experiments, verbally ask questions about, discuss, explain or report any step of scientific method.	Write, report, tell, explain, graph, describe, present, picture, diagram, make a table of, ask, discuss, chat, argue, claim, reason, say
Hypothesizing	Stating a problem to be solved as a question/propose a testable solutions or expected outcomes for experiments	Hypothesize, assume, theorize, conceive, offer, imagine, propose, suggest
Defining and Controlling Variables	Stating the changeable factors that can affect an experiment, identify and defining the independent and dependent variables, defining the relations among variables in an experiment, controlling manipulated variables in an investigation.	Define variables, control the variables, show how to manipulate variables, handle the variables

Name of skill	Definition	Key Words
Experimenting and Designing Experiment	Testing the hypotheses through previously prepared experiment set up, testing a hypothesis through designing an experiment.	Follow, perform, make, do, achieve, design the experiment, test the hypotheses
Gathering and Interpreting Data	Gathering data through valid and reliable instrument in order to test hypothesis, creating or using tables, graphs, or diagrams to organize and explain information.	Gather, collect, put together, interpret data, organize data, and explain data by using graphs, diagrams, make table of data, show data in a meaningful pattern
Making Models	Making a pictorial, written or physical representation to explain an idea, event, or object.	Picture, graph, diagram, model about the idea, phenomena, objects.

APPENDIX J

FIRST DRAFT OF THE CODE BOOK

Gözlem Yapma

Nesneler ya da olaylar hakkında doğrudan bilgi elde etmek amacıyla duyuların ya da değişik ölçüm aletlerin kullanıldığı incelemelerdir. Gözlem yaparken nesnelerin özelliklerine, hareketlerindeki ya da yapılarındaki değişime dikkat edilir. Etkili bir gözlem belirli bir amaç doğrultusunda dikkatli ve sistemli bir şekilde yapılır. Gözlemler nitel ya da nicel olabilir. Nitel gözlemler suyun kaynamasının, çiçeğin boyunun uzamasının gözlenmesi gibi ölçüm gerektirmeyen gözlemlerdir. Suyun kaynamasını önceden başlayarak sıcaklığı ölçerek ya da bitkinin boyunu belli zaman aralıklarıyla ölçerek yapılan gözlemler nicel gözlemlerdir.

Gözlem yapma birimi belirlenirken dikkat edilmesi gereken husus yapılacak gözlemin bir amaca hizmet edeceğinin vurgulanmasıdır. Örneğin bir kuşun hareketinin sadece izlenmesini sağlamak yeterli değildir.

Gözlem yapma birimini belirleme

- Gözlem yapmanın bilimsel bir süreç olduğu ifade ediliyorsa
- Bilim adamlarının çalışmalarında gözlem yaptıkları ifade ediliyorsa
- Öğrenciye gözlem yaptırılıyorsa: Nesnelerde meydana gelen değişimi duyularını (görme, işitme, koklama, dokunma ve tat alma) kullanarak belirlemesi sağlanıyorsa
- Öğrenciye bir amaç doğrultusunda nitel gözlem yaptırılıyorsa
- Öğrenciye bir amaç doğrultusunda nicel gözlem yaptırılıyorsa
- Nesneler veya olaylar arasında belirgin benzerliklerin ve/ veya farklılıkların saptanması isteniyorsa
- Gözlem için gerekli uygun araç-gereçleri seçmesi isteniyorsa
- Gözlem sonuçlarını değerlendirip ilgili olanları ayırması isteniyorsa
- Gözlem sonucunda amacını değerlendirmesi isteniyorsa

Ölçme

Bir nesne ya da sistemdeki gözlemlenen değişikliklerin nicel veriye dönüştürülmesidir. Ölçme en basit anlamda sayma ve kıyaslamadır; ölçülebilir büyüklükleri, standart ya da standart olmayan birimler cinsinden ifade etmektir. Ölçme işlemi standardize edilmiş aletlerle yapıldığı gibi standart olmayan yollarla da yapılabilir. Derslerde ağırlık, kütle, uzunluk, sıcaklık gibi özellikler bilimsel aletlerle ölçülebilir.

Ölçüm yapılarak açıklama ve tahminlerin niteliğini, tanımlamaların kesinliğini arttırır.

Ölçme yapma birimini belirleme

- Ölçme yapmanın bilimsel bir beceri olduğu ifade ediliyorsa
- Bilim adamlarının çalışmalarında ölçümler yaptıkları ifade ediliyorsa
- Uygun ölçüm birimlerini kullanarak nicel tanımlama yapması isteniyorsa
- Nicel verileri kaydetmesi isteniyorsa
- Uzay zaman ilişkisi kurması isteniyorsa
- Elde edilen verilerin anlamlı olup/olmadığı üzerine düşünmesi isteniyorsa

Çıkarım Yapma

Çıkarım bir gözlemin nedenleri konusunda yapılan tahminlerdir. Burada dikkat edilmesi gereken nokta tahmin edilen şeyin bir olayın nedenine dair olmasıdır. Çıkarım yapmak için verilere ihtiyaç vardır; ancak yapılan gözlemler sonucunda elde edilen verilere dayanarak gözlemin nedenleri hakkında çıkarımlarda bulunmak mümkündür.

Çıkarım yapma birimini belirleme

- Çıkarım yapma birimi belirlenirken öğrenciye yaptırılmak istenen tahminin bir olayın nedenini açıklamaya yönelik olup olmadığına dikkat edilmelidir.
- Çıkarım yapmanın bilimsel bir beceri olduğu ifade ediliyorsa
- Bilim adamlarının çıkarımlarda bulunduğu ifade ediliyorsa
- Yapılan gözlemleri kullanarak bir olayın nedenine dair bir açıklama getirmesi sağlanıyorsa
- Bir olayın olası nedenleri hakkında öğrencilerin verilere dayanarak tartışması sağlanıyorsa

Sınıflandırma

Bilgilerin organize edilmesinde önemli bir yol olan sınıflandırma, nesne ya da olayların sahip oldukları benzer ve farklı özelliklerine göre gruplandırılmasıdır. Sınıflandırma gözlem yoluyla elde edilen veriler doğrultusunda yapılır. Gözlem sonucunda ulaşılan veriler dikkate alınarak nesne ya da olaylar birbiriyle karşılaştırılır ve düzenlenir.

Sınıflandırma birimini belirleme

- Sınıflandırma birimi belirlenirken, öğrenciye elde edinilen bilgiler dikkate alınarak nesne ya da olayları benzer ve farklı özellikleri doğrultusunda karşılaştırarak, gruplara ayırmasına dikkat edilmelidir.
- Sınıflandırmanın bilimsel bir beceri olduğu ifade ediliyorsa,
- Bilim adamlarının bir takım sınıflandırmalar yaptıkları ifade ediliyorsa,
- Öğrencinin toplanılan ya da verilen bilgiler doğrultusunda sıralama yapması isteniyorsa,
- Nesne ya da olayları aralarındaki ilişkilere göre düzenlemeleri isteniyorsa, tablo yapılması isteniyorsa
- Yapılan sınıflandırmada kriterleri belirlemesi isteniyorsa, grupları birbirinden ayıran özellikleri ifade etmesi/belirlemesi/tartışması isteniyorsa

Tahmin Etme

Bir olayın sonucunu elde edilen verilere dayanarak önceden kestirmedir. Tahmin doğru, yanlış ya da eksik olabilir. Derste bir deney ya da etkinlik yapılmadan önce karşılaşılabilecek sonuçlar üzerinde yapılan tartışmalar bu beceriyi içerebilir. Bu noktada önemli olan öğrencinin yaptığı tahminin doğru, yanlış ya da eksik olup olmadığını öğrenmesidir. Sadece tahmin etmesini sağlayıp orada bırakmak yeterli değildir.

Tahmin etme birimini belirleme

- Tahmin etmenin bilimsel süreç becerilerinden olduğu ifade ediliyorsa
- Öğrencilere bir olayın nedenine ilişkin tahminde bulunması isteniyorsa
- Öğrencilere verilere dayanarak nasıl tahmin yürütülebileceği anlatılıyorsa

İletişim Kurma

Düşünce ve yorumların sözlü ya da yazılı şekilde paylaşılmasıdır. Öğrencilerin gözlemlerini, elde ettikleri verileri, yaptıkları çıkarım ve/veya tahminleri, hipotezlerini, değişkenleri nasıl kontrol ettiklerini, tasarladıkları deneyleri, ulaştıkları sonuçları, bunlar hakkındaki düşünce ve yorumlarını, sınıf, grup, sıra arkadaşlarıyla paylaşmaları beklenmektedir. Öğrenciler düşüncelerini ifade ederken sözlü anlatımın yanında yazılı materyallerden de faydalanmalıdır. Grafik yorumlama ve çizme, tablo okuma ve oluşturma, rapor yazma ve değerlendirme, sunum yapma, tartışma bilimsel iletişim becerisini geliştirir. Ayrıca öğrencilerin bilimsel bir gelişme hakkında yaptıkları tartışmalarda bu birimin içerisine girer; ancak bilimsel bir çerçevede değerlendiriliyorsa olay.

İletişim kurma becerisi birimini belirleme

- Öğrencilerin gözlemlerini, elde ettikleri verileri, yaptıkları çıkarım ve/veya tahminleri, hipotezlerini, değişkenleri nasıl kontrol ettiklerini, tasarladıkları deneyleri, ulaştıkları sonuçları, bunlar hakkındaki düşünce ve yorumlarını, sınıf, grup, sıra arkadaşlarıyla paylaşmaları teşvik ediliyorsa,
- Elde edilen veriler doğrultusunda değişkenlerin grafiklerinin çizilmesi isteniyorsa,
- Elde edilen verilerde tablo oluşturulması isteniyorsa,
- Yapılan bir çalışma, deney, gözlem vs. hakkında sunum yapması isteniyorsa
- Bilimsel bilginin oluşmasında, yayılmasında iletişimin etkisi vurgulanıyorsa

Hipotez Kurma

Düşünce ve tecrübelere dayanarak bir deneyin sonucu hakkında yapılan kontrollü tahminlerdir. Hipotez neden-sonuç ilişkisi hakkında bilgi verir, bilimsel bir çalışmada sonucu etkileyecek, dikkat edilmesi gereken verileri seçmede ve bu verilerin yorumlanmasında rehberlik eder. Bilimsel bir çalışma için en temel nokta olan hipotez kurma, öğrencilerin var olan bilgileri ile öğrenilen bilgi arasında kavramsal bir bağ şekillendirir. Hipotez oluşturulurken tam geliştirilmemiş ve test edilebilir bir ifade kullanılır.

Hipotez kurma becerisi birimini belirleme

- Hipotez kurmanın bilimsel bir süreç olduğu ifade ediliyorsa
- Bilim adamlarının çalışmalarında hipotez kurdukları ifade ediliyorsa, hipotezlerine yer veriliyorsa
- Hipotezin nasıl kurulduğunu anlatıyorsa
- Öğrencilerden bir deney/araştırma için hipotez kurmaları isteniyorsa,
- Bir olayı ya da ilişkiyi açıklaması için tahminde bulunması ve tahminin doğruluğunun sınanması isteniyorsa

Değişkenleri Belirleme, Tanımlama ve Kontrol Etme

Yapılacak deneyi etkileyebilecek tüm etkenlerin ifade edilmesidir. Farklı koşullar altında değiştirilmesi veya sabit tutulması ile deneyin düzenini etkileyecek tüm faktörlerin belirlenmesidir. Gözlenen bir sonucun nedenini bulmak için mevcut değişkenlerin tanımlanması; sabit tutulacak ve idare edilecek değişkenlerin belirlenmesidir. Bunun yapılmasının nedeni diğer değişkenlerin sonucu etkileyebilme olasılıklarını ortadan kaldırmaktır. Böylece, deney sonucunu bir değişkene bağlamak ve değişen ile sonuç (bağımlı ve bağımsız değişkenler arasındaki) arasındaki ilişkiden anlamalı bir sonuç çıkarmak mümkün olur.

Değişkenleri Belirleme, Tanımlama ve Kontrol Etme becerisi birimini belirleme

- Değişkenleri belirlemenin bilimsel bir süreç olduğu ifade ediliyorsa
- Bilim adamlarının çalışmalarında hipotez kurdukları ifade ediliyorsa, hipotezlerine yer veriliyorsa
- Deneyden önce, deneyi etkileyebilecek değişkenler net bir şekilde tanımlanabiliyorsa,
- Deney sürecinde belirlenen değişkenlerden hangilerinin sabit tutulacağına karar veriliyorsa,
- Deney sürecinde değişkenler kontrol edilebiliyorsa
- Beklenen sonucu vermeyen bir deneyin neden beklendiği şekilde sonuçlanmadığını hakkında sorgulama yapılıyorsa,
- Beklenen sonucu vermeyen bir deneyin neden beklendiği şekilde sonuçlanmadığını hakkında sorgulama yaptırılıyorsa

Deney Tasarlama ve Yapma

Deney yapma deneysel süreçlerin en karmaşık olanıdır. Aynı zamanda bu süreç becerisi diğer becerileri de kapsar. Deney yapmanın asıl amacı bir hipotez kurup onun yardımıyla değişkenler arasında ilişki kurmaktır. Deney yapmada tek bir yol izlenebileceği gibi farklı yollar da izlenebilir. Burada en önemli faktör öğrencinin deneyle ilgili düzeneği kurabilmesi ve deneyin amacını anlayabilmesidir.

Deney Tasarlama ve Yapma birimini belirleme

- Deney düzeneği tasarlamanın bilimsel bir süreç olduğu ifade ediliyorsa,
- Bilim adamlarının deneyler üzerine çalıştıkları, düzenekler tasarladıkları ifade ediliyorsa, bu çalışmalardan örnek veriliyorsa.
- Öğrencilere adımları belirlenmiş bir deney yaptırılıyorsa
- Öğrencilerden bir hipotezi sınamaları ya da bir soruya cevap vermeleri için deney düzeneği tasarlamaları isteniyorsa

Veri Toplama, Yorumlama

Yapılan çıkarım, tahmin veya oluşturduğu bir hipotez ışığında çeşitli metotlarla veri toplayabilmek, akla uygun sonuçlara varmak için topladığı verileri, dayanağı olan bir mantık dokusu içinde yorumlayabilmek. Deney yapma sürecinde ve gözlemler boyunca veri toplanır. Veriler nicel ya da nitel olabilir. Toplanan verilerin organize edildikten sonra yorumlanması gerekir. Verileri yorumlamak ise veriler üzerinde mantıklı düşünülerek sonuçlar çıkarılmasıdır. Verileri yorumlarken, bağımlı ve bağımsız değişkenin arasındaki ilişkiden ne anladığımızı belirtiriz.

Veri toplama ve yorumlama birimini belirleme

- Veri toplamanın, verileri sistematik bir şekilde düzenlemenin, gereksiz bilgilerden arındırmanın ve/veya yorumlamanın bilimsel bir süreç olduğu ifade ediliyorsa,
- Bilim adamlarının düzenli bir biçimde verileri topladıkları, organize ettikleri ve akla uygun bir şekilde yorumladıkları ifade ediliyorsa.
- Değişkenlerle yapılan denemelere ait hipotez ile uyumlu veriler toplatılıyorsa,
- Toplanan veriler anlamlı bir düzen çerçevesinde organize ediliyorsa,
- Veriler, deneyin sonucunu etkilemeyecek ve/veya kafa karışıklığına yol açacak gereksiz bilgilerden arındırılıyorsa
- Verilerin yorumlanması için görsel formlardan (grafik, tablo, sütunlu grafik vb. gibi) faydalanılması teşvik ediliyorsa,
- Verilen bir görsel formu (grafik, tablo vb. gibi) yorumlayabiliyorsa
- Deneyden önce yapılan tahminler ile deneyde elde edilen veriler doğrultusunda buldukları sonuçları karşılaştırmaları isteniyorsa
- Verileri karşılaştırıp yorumlayarak bunların anlamlarından bazı sonuçlar çıkarmaları isteniyorsa.
- Bağısız ve bağımlı değişken arasındaki ilişkiyi tanımlatıyorsa,
- Elde edilen sonuçların genel uygulanabilirliği hakkında varsayımlarda bulunmaları isteniyorsa.

Model Yapma

Modeller rahatlıkla göremediğimiz nesnelerin somut örnekleri olabilirler. Çok büyük nesnelerin küçültülmüş, çok küçük nesnelerin büyültülmüş örnekleri olabilirler. Bazı olayları fiziksel ya da zihinsel model oluşturarak gösterebilme

Model yapma biriminin belirlenmesi

- Model yapmanın bilimsel bir süreç olduğu ifade ediliyorsa,
- Bilim adamlarının anlaşılması güç kavramların, nesnelerin ve olayların modellerini yaparak anlaşılır hale getirdikleri ifade ediliyorsa
- Öğrencilerden bilinen bir modeli yapmaları isteniyorsa
- Öğrencilerden yeni öğrendikleri bir kavramı ya da olayı modellemeleri isteniyorsa

APPENDIX K

BİLİMSEL SÜREÇ BECERİLERİ KOD REHBERİ – TASLAK 1

Bu kod rehberi, Ortaöğretim 9. Sınıf Fizik Dersi Kitabının *bilimsel süreç becerileri* (BSB) bakımından nesnel ve sistematik bir şekilde incelenmesi için hazırlanmıştır. Kod rehberi , (1) Giriş, (2) Analiz birimleri, (3) Kategoriler, (4) Analiz kuralları olmak üzere dört ana bölümden oluşmaktadır. Birinci bölüm, içerik analizi hakkında kısa ve öz bir açıklamadan oluşan giriş bölümüdür. İkinci bölümde analiz birimleri hakkında bilgi verilip, çalışmanın bağlam ve kayıt birimleri açıklanmıştır. Üçüncü bölümde bilimsel süreç becerilerine ait kategoriler tanımları ve örnekleriyle açıklanmıştır. Son bölüm olan dördüncü bölümde dikkat edilmesi gereken analiz kurallarına yer verilmiştir.

A. Giriş

Günümüzde fen bilimleri eğitimi fen bilgisi yanında, bilimsel düşünmeyi ve bilimsel süreçlere ilişkin becerileri geliştirmeye yönelik hedefleri de içermektedir. Bu yaklaşım öğretim programlarından başlayarak ders kitaplarına yansımaktadır. Gelişmiş ülkelerde bilimsel süreç becerileri ders kitaplarında sistematik bir şekilde yer almaktadır. Öğrenci ders kitapları, öğrencilerin farkına varmadan üç yönlü düşünme becerilerini geliştirebileceği bir estetik ve inceliğe sahiptir. Kitaplar, çeşitli etkinlik, uygulama ve sorularla öğrencide a) bilimsel süreç becerileri b) eleştirel düşünme becerileri c) bilimsel muhakeme becerileri olmak üzere üç yönlü düşünme gelişimini sağlayacak tarzda yapılandırılmıştır (Dökme, 2004). Bu düşünme becerilerinden *Bilimsel Süreç Becerileri*, Çepni, Ayas, Johnson ve Turgut, (1996) tarafından "fen bilimlerinde öğrenmeyi kolaylaştıran, öğrencilerin aktif olmasını sağlayan, kendi öğrenmelerinde sorumluluk alma duygusunu geliştiren, öğrenmenin kalıcılığını arttıran, araştırma yolları ve yöntemlerini gösteren temel beceriler" olarak tanımlanmıştır. Temel bilimsel süreç becerileri; gözlem yapma, ölçme, çıkarım yapma, sınıflandırma, tahmin etme ve bilimsel iletişim kurma becerilerinden oluşur. Bütünleşik bilimsel süreç becerileri ise; hipotez kurma, deney tasarlama/yapma, değişkenleri belirleme/kontrol etme, veri toplama/yorumlama ve model yapma becerileridir.

İçerik analizi, yazılı ya da resimli bir belgeden araştırmacının incelemek istediği mesajın nicelleştirilmesidir (Krippendorff, 2004). Berelson (1952), ise içerik analizini iletişimin açık içeriğinin nesnel, sistematik ve nicel tanımlarını yapan bir araştırma tekniği olarak tanımlamıştır. Bu içerik analizinin amacı, ülkemizde Ortaöğretim 9.sınıfta kullanılan Fizik Ders Kitabında bilimsel süreç becerilerine ne kadar yer verildiğini nesnel, sistematik ve nicel bir şekilde ortaya çıkarmaktır.

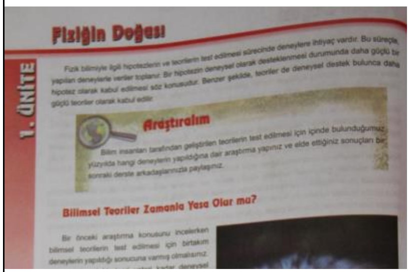
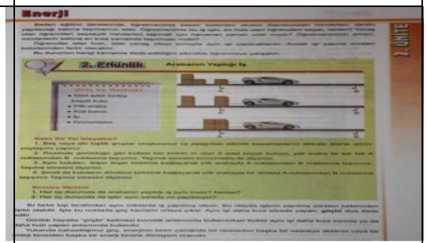
B. Analiz Birimleri

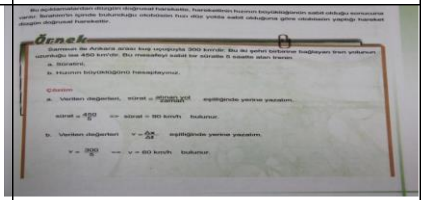
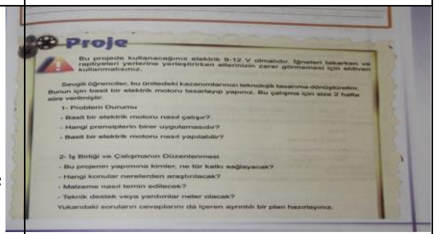
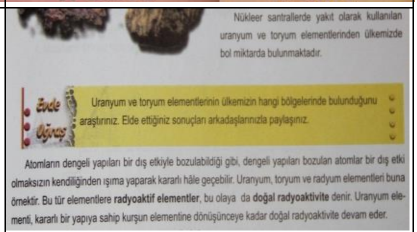
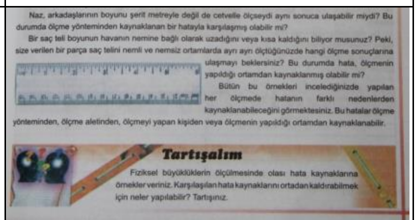
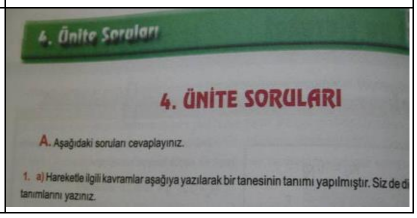
Bu çalışmada kodlama işlemi, kayıt birimi ve bağlam birimi (context unit) dikkate alınarak yapılır. Kayıt birimi, “iletişim içeriğinin belli bir kategoriye yerleştirilecek olan en küçük çözümleme birimidir. Bağlam birimi ise, kayıt birimini değerlendirmek için, içinde yer aldığı bağlamı sınırlandıran en geniş bölümdür (Tavşancıl, & Aslan, 2001). Kullanılan birim türleri analiz edilen belgenin niteliğine ve içeriğine göre değişiklik gösterir. Ortaöğretim 9. Sınıf Fizik Dersi Kitabı içerik analizi için belirlenen bağlam birimleri ve kayıt birimlerine aşağıda detayları ile yer verilmiştir.

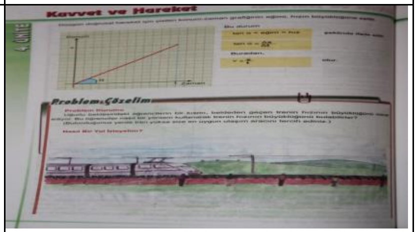
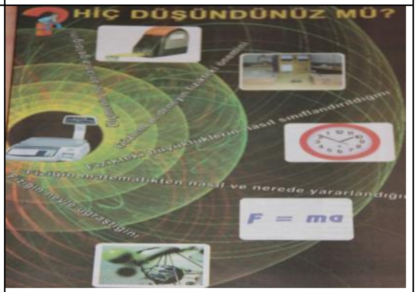
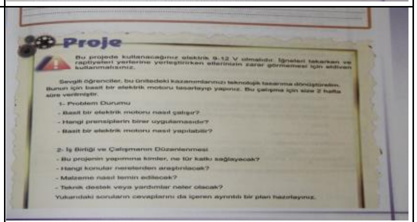
B.1. Bağlam Birimleri

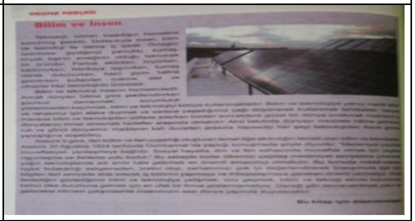
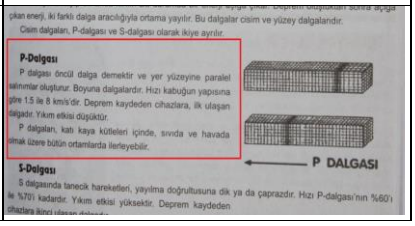
Bu çalışmada bağlam birimi olarak kitapta ana metinden bir başlıkla, değişik renkte fon ve/veya çerçeve ile ayrılan bölümler ve bir anlam bütünlüğü taşıyan paragraflar olarak belirlenmiştir. Tablo 1’de bu bölümlere, araştırmada kullanılacak sembollerine, açıklama ve örneklerine yer verilmiştir.

Tablo1. Bağlam Birimleri

Bölüm adı	Kod	Açıklama	Örnek
Araştıralım	A	Kitapta ana metinlerin arasına yerleştirilmiştir, açık yeşil çerçevesi ile diğer paragraf ve bölümlerden ayrılır. Öğrenilen kavramlar derinlemesine irdelenerek günlük hayatla bağlantıları için farklı kaynaklardan araştırılır ve sonuçlar sınıfta paylaşılır.	
Etkinlik	E	Kendine özel sarı fonu ile diğer paragraf ve bölümlerden ayrılır. Bu bölümde öğrencilerin, verilen araç gereçleri kullanarak istenilen bilgiyi kendi gayretleriyle keşfetmeleri beklenir.	
Bunları Biliyor musunuz?	BB	Kendine ait fonu ve üzerindeki kafasında 3 adet soru işareti bulunan bir insan kafasıyla diğer paragraf ve bölümlerden ayrılır. Öğrenilen konularla ilgili dikkat çekici öz bilgiler sunulur.	

Tablo1. Bağlam Birimleri (Devam)			
Bölüm adı	Kod	Açıklama	Örnek
Örnek	O	Sayfada kahverengi çizgi ile çerçevelenmiş ‘Örnek’ bölümünde örnek sorular çözümleriyle yer almaktadır. Bu kısımda soru ve cevap bir bütün olarak kabul edilir.	
Proje	P	Sol köşesinde değişik boylarda 3 dişlinin, bulunduğu, metinlerden açık sarı fon ve yeşil çerçeve ile ayrılır. Keşfedilen bilgiler öğrencilerce bir sistem içinde uygulamaya dönüştürülür.	
Ünite giriş sayfası	UG	Bu bölüm her ünitenin, ünite başlığından sonra gelen ilk sayfasında yer alır. Konu ile ilgili bir resim, ana konu başlıkları ve ünitede nelerin öğrenileceğine dair açıklamadan oluşur.	 
Evde Uğraş	EU	Öğrencilerin bazı kazanımları genişletmek amacı ile sınıf dışında yapacağı çalışmaları içeren sarı fonu ve sol kenarında alt alta dizili noktalarıyla diğer bölüm ve paragraflardan ayrılan bölüm.	
Tartışalım	T	Bazı yasa ve teorilerin gelişim süreçlerinin tartışıldığı bölüm olarak tanımlanan ‘Tartışma Soruları’, sol tarafında iki kafa ve soru işaretleriyle diğer bölüm ve paragraflardan ayrılır.	
Ünite Soruları	US	Her ünitenin sonunda yer alan değişik soru çeşitlerini içeren değerlendirme sorularıdır.	

Tablo1. Bağlam Birimleri (Devam)			
Bölüm adı	Kod	Açıklama	Örnek
Problem Çözelim	PC	Günlük hayatta karşılaşılabilecek sorunlara çözüm arayan ‘Problem Çözelim’ bölümü bir çerçeve ile diğer bölüm ve paragraflardan ayrılır. Fonu, yer aldığı ünite renginin açık tonudur.	
Hiç düşündünüz mü?	HD	Ünite boyunca işlenecek konularla ilgili hazırlık için dikkat çekecek nitelikte ünitedeki ana amaçları içeren soruları kapsayan bölüm. Her ünitenin giriş sayfasından sonraki ilk sayfadır.	
Ünite Bağlamı	UB	Ünitede geçen kavramlarla, günlük hayatta kullanılan teknolojik araç gereç veya olaylarla ilişki kurmak için yazılan bölümdür. Ünitelerde ‘Hiç Düşündünüz mü’ bölümünden sonra yer almaktadır, bazı ünitelerde bu bölüme yer verilmemiştir.	
Dikkat	D	Bazı etkinliklerin ve araştırmaların gerçekleştirilmesi esnasında doğabilecek tehlikelere karşı alınması gereken tedbirleri içeren bölüm.	
Pekiştirelim	Pk	Ünitede öğrenilen kavramların daha kalıcı hale getirilmesinin hedeflendiği bölüm	
Kutu	K	Belli bir başlığı olmayan, ana metinden üniteden üniteye değişen renkteki fonu ile ayrılan bölüm.	

Tablo1. Bağlam Birimleri (Devam)			
Bölüm adı	Kod	Açıklama	Örnek
Şema	S	Bir çerçeve ile ana metinden ayrılmış şemalar	
Okuma Parçası	OP	Bazı Ünitelerin sonlarında bulunan okuma parçalarıdır. Ayrı bir sayfada başlar, mor renginde fonu ile ayırt edilir.	
Paragraf 1	P1	Bir paragraf olarak anlam bütünlüğü taşır.	
Paragraf 2	P2	Anlam bütünlüğü birden fazla paragraf ile sağlanır.	

B.2. Kayıt Birimleri

Kayıt birimi, içeriğin belli bir kategoriye yerleştirilecek olan en küçük çözümleme birimi olarak ifade edilmişti. Bu çalışmada belirlenen kayıt birimleri şöyledir;

1. Paragraf
2. Cümle ya da cümleler
3. Sorular
4. Etkinliklerin her bir maddesi (basamağı) ya da paragrafı (her biri ayrı bir kayıt birimi olarak değerlendirilir.)
5. Açıklaması olan tablo
6. Açıklaması olan resim
7. Açıklaması olan şekil

C. Kategoriler

1. Gözlem Yapma (G)

Gözlem yapma, herhangi bir duyu organıyla veya farklı araç-gereçlerle nesne ya da olaylar hakkında doğrudan bilgi elde etmek için yapılan işlemdir (Carin, & Bass, 2001; Buxton, & Provenzo, 2007; Harlen & Qualter 2009). Beş duyunun (görme, koklama, duyma, tatma ve dokunma) herhangi biri veya birden fazlasının ayrı ayrı ya da birlikte kullanılarak nesne ya da olaylar hakkında veri toplanmasıdır (Martin, 2006). Gözlem yaparken nesnelerin özelliklerine, hareket ya da yapılarındaki değişime, olaylardaki değişime dikkat edilir (Buxton, & Provenzo, 2007). Etkili bir gözlem, belirli bir amaç doğrultusunda dikkatli ve sistemli bir şekilde yapılır (Carin, & Bass, 2001). Gözlemler nitel ya da nicel olabilir. *Nitel gözlem* çiçeğin boyunun uzaması, yüzeyin pürüzlü olması, çürüyen bir meyvenin kokması gibi doğrudan duyu organlarıyla yapılan gözlemlerdir. *Nicel gözlem* ise nesne ya da olay ile ilgili verinin standart olan ya da olmayan birim cinsinden ifade edilerek yapılan gözlemlerdir (Martin, 2006). Örneğin çiçeğin boyunun kaç santimetre uzadığını cetvelle ölçmek, suyun kaynama sıcaklığını belirlemek için termometre ile ölçerek meydana gelen değişikliği gözlemlemek gibi.

Gözlem Yapma Kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	GBK1 GBK2	Gözlem yapmanın bilimsel süreç becerisi olduğunu ifade eder Bilim adamlarının çalışmalarında gözlem yaptıklarını ifade eder
	İşlemsel Bilgi	GBI1	Gözlem yapma becerisi hakkında bilgi verir: Nasıl gözlem yapılması gerektiği/Gözlem yaparken hangi hususlara dikkat edilmesi gerektiği hakkında bilgi verir.
Zihinsel İşlem Boyutu		GZI1	Öğrenciye gözlem yaptırır: Nesnelerde meydana gelen değişimi duyularını (görme, işitme, koklama, dokunma ve tat alma) kullanarak belirlemesini ister Öğrenciye bir amaç doğrultusunda nitel gözlem yaptırır Öğrenciye bir amaç doğrultusunda nicel gözlem yaptırır

Gözlem yapma kategorisi için örnek

Etkinlik / Gazların Hacmi Var mı?
Araç ve Gereçler Kalsiyum tablet, balon, deney tüpü, su Nasıl Bir Yol İzleyelim? 1. Deney tüpüne bir miktar su koyarak içine kalsiyum sandoz tabletini atınız. 2. Hiç vakit kaybetmeden balonu, deney tüpünün ağzına resimdeki gibi geçiriniz. Sonuca Varalım 1. Balonu deney tüpünün ağzına geçirdikten sonra balonda ne gibi değişiklik gözlemlediniz? Bu değişikliğin sebebi ne olabilir? 2. Günlük hayattan bu etkinlikteki olaya benzer örnekler verebilir misiniz? 3. Yaptığınız etkinlikten hareketle gazların hacimleri ile ilgili ne söyleyebilirsiniz? Ortaöğretim Fizik 9/ Sayfa 109

Gözlem yapma kategorisi örneği için açıklama**:** Sonuca Varalım kısmında 1. Maddede yapılan uygulama sonucunda gerçekleşecek değişikliğin gözlemlenmesi istenmektedir. Öğrenciden balonda meydana gelecek değişikliği gözlemlemesi isteniyor, bu da gözlem yapma kategorisinde GZI kodlu öğrenciye gözlem yaptırır maddesine karşılık gelmektedir.

2. Ölçme (O)

Ölçme en basit anlamda sayma ve kıyaslamadır; ölçülebilir büyüklükleri, standart -olan ya da olmayan birimler cinsinden ifade etmektir. Ölçme işlemi standardize edilmiş aletlerle yapıldığı gibi standart olmayan yollarla da yapılabilir (Wolfinger, 2000). Örneğin bir odanın uzunluğu ölçen kişinin adımı ile ölçülüyorsa standart olmayan bir ölçüm cinsinden ölçülmüş olur, bir metre yardımı ile ölçülüyorsa standart bir ölçüm birimi olan ‘metre’ cinsinden belirlenmiş olur. Ölçüm yapılarak, açıklama ve tahminlerin niteliği, tanımlamaların kesinliği arttırılır (Carin & Bass, 2001; Buxton & Provenzo, 2007).

Ölçüm Yapma Kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	OBB1 OBB2	Ölçmenin bilimsel süreç becerisi olduğunu ifade eder Bilim adamlarının çalışmalarında ölçümler yaptıklarını ifade eder
	İşlemsel Bilgi	OBI	Ölçüm yapma becerisi hakkında bilgi verir: Herhangi bir şeyin nasıl ölçüleceği/ Ölçüm yaparken dikkat edilmesi gereken hususlar hususlar hakkında bilgi verir
Zihinsel İşlem Boyutu		OZI1	Öğrenciden bir şeyi ölçmesini ister Öğrenciden nicel betimleme yapmasını ister Öğrenciden nitel betimleme yapmasını ister

Ölçme kategorisi için örnek

Etkinlik / Farklı Maddelerle Yapılan Termometrelerle Aynı Sıcaklığın Ölçülmesi

Araç ve Gereçler
Civalı termometre, Alkollü termometre, Beher, Bunzen beki, Üçayak, Su

Nasıl Bir Yol İzleyelim?

1. Resimdeki düzeneği kurunuz.
2. Su kaynayıncaya kadar belli aralıklarla her iki termometrenin gösterdiği değerleri, aşağıdakine benzer bir çizelgeyi defterinize çizerek uygun yerlere yazınız.

Ölçümler	Alkollü Termometre	Civalı Termometre
1. Ölçüm		
2. Ölçüm		

(Örnek çizelgedir.)

Sonuca Varalım

1. Alkollü ve Civalı termometrelerle yaptığınız ölçümler arasında fark var mı?
2. Farklılık kaç dereceden sonra başladı?
3. Sizce hangi termometre sonuçları daha doğru gösterdi?
4. Alkollü termometre ile en son hangi değeri ölçebildiniz?

Ortaöğretim Fizik 9/ Sayfa 79

Ölçme kategorisi örneği için açıklama**:** Bu etkinlikte öğrencilerden iki farklı termometre ile ölçüm yapmaları ve bu verileri kaydetmeleri istenmektedir, bu da OZI maddesi, nicel verileri kaydetmesi istenir ile örtüşmektedir.

3. Çıkarım Yapma (C)

Çıkarım, bir gözlem ya da olayın nedenleri hakkında en iyi tahminin yapılmasıdır (Martin, 2006). Önceki bilgi ve deneyimlere dayalı olarak gözlenen olayları yorumlamayı gerektirir (Carin & Bass, 2001; Buxton & Provenzo, 2007). Burada dikkat edilmesi gereken nokta, çıkarım yapmayı tahmin etme becerisinden ayırt edebilmektir. Tahmin etmek henüz gerçekleşmemiş bir olayın sonucunu önceden kestirebilmek iken çıkarım yapmak gerçekleşmiş olayın nedenlerini açıklamaya yönelik fikir yürütmektir. Doğru ve etkili çıkarım yapmak için gözlem yapılmalı ve veriler toplanmalıdır. Bu bağlamda gözlem yapma ile çıkarım yapma becerileri arasındaki ilişkinin vurgulanması da önemlidir.

Çıkarım yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	CBB1	Çıkarım yapmanın bilimsel süreç becerisi olduğunu ifade eder
		CBB2	Bilim adamlarının çıkarımlarda bulunduklarını ifade eder
	İşlemsel Bilgi	CBI1	Çıkarım yapma becerisi hakkında bilgi verir: Çıkarım yaparken nelere dikkat edilmesi gerektiği hakkında bilgi verir/ Çıkarım yapmanın tahmin etme becerisinden farkını vurgular/ Çıkarım yapmanın iyi gözlem yapmaya bağlı olduğunu ifade eder
Zihinsel İşlem Boyutu		CZI1	Öğrenciden bir olayın nedenine dair açıklama yapmasını ister Öğrencilerden bir olayın olası nedenleri hakkında verilere dayalı olarak tartışmalarını ister

Çıkarım yapma kategorisi için örnek

Etkinlik / Dalga Hareketini Gözlemleyelim Araç ve Gereçler Dalga leğeni, üç adet mantar ya da strafor, yeterli miktarda su, ışık kaynağı, Reosta, Güç kaynağı Nasıl Bir Yol İzleyelim? 1. Beş veya altı kişilik gruplar oluşturunuz ve aşağıdaki etkinlik basamaklarını dikkate alarak görev paylaşımı yapınız. 2. Etkinlikte kurduğunuz düzeneğin üzerine resimdeki gibi bir ışık kaynağı yerleştiriniz. 3. Öndeki mantarı elinizle titreştirip meydana gelen değişimin, ışık kaynağı yardımıyla dalga leğeninin zeminine düşürülen görüntüsünü gözlemleyiniz. Sonuca Varalım 1. Dalga leğeninde oluşan değişimin ışıkla elde edilen görüntüsünde, titreşim mantarlara ulaştığı an mı mantarlar titreşmeye başlamıştır? 2. Bir müddet sonra mantarların sırayla aşağı yukarı titreşim yapmalarına rağmen yerlerini terk etmemeleri sizce ne anlama gelir? 3. Oluşturulan titreşimin dalga leğeninin diğer bölgelerinde varlığını göstermesini nasıl açıklarsınız? Ortaöğretim Fizik 9/ Sayfa 216

Çıkarım yapma kategorisi örneği açıklama: Bu etkinlikte Sonuca Varalım kısmının 3.

Maddesinde gerçekleşmiş bir olay titreşimin dalga leğeninin diğer bölgelerinde olmamasının nedeni sorulmaktadır. Bu nedenle çıkarım yapma bağlam biriminde CZI "Öğrenciden bir olayın nedenine dair açıklama yapması istenir" maddesi ile örtüşmektedir.

4. Sınıflandırma (S)

Bilgilerin organize edilmesinde önemli bir yol olan sınıflandırma, nesne ya da olayların sahip oldukları benzer ve farklı özelliklerine göre gruplandırılmasıdır (Wolfinger, 2000). Sınıflandırma bilgi birikimi ve gözlem yoluyla elde edilen veriler doğrultusunda yapılır. Dikkat edilmesi gereken nokta sınıflandırma parametresinin açık ve net olması; sınıflandırma yapılırken herhangi bir karışıklığa neden olmamasıdır. Bu yüzden seçilen parametre öznel değil nesnel olmadır. Örneğin sinema filmlerini eğlenceli, sıkıcı, komik gibi kategorilere ayırmak yerine, filmleri türüne göre sınıflandırmak daha sağlıklı olur (Settlage & Southerland, 2007).

Sınıflandırma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	SBB1	Sınıflandırmanın bilimsel süreç becerisi olduğunu ifade eder
		SBB2	Bilim adamlarının çalışmalarında sınıflandırma yaptıklarını ifade eder
	İşlemsel Bilgi	SBI1	Sınıflandırma becerisi hakkında bilgi verir: bilim adamlarının yaptık ları sınıflandırmalarda nasıl bir yol izledikleri/ Sınıflandırma yaparken dikkat edilmesi gereken hususlar hakkında bilgi verir
Zihinsel İşlem Boyutu		SZI1	Nesne ya da olayların istenen ortak özelliklerini belirlemesi istenir Nesne ya da olayların istenen farklı özelliklerini belirlemesi istenir Nesne ya da olayları ilişkilerine göre düzenlemesi istenir Verilen bilgiler doğrultusunda sınıflandırma yapması istenir
		SZI2	Bilinen bir sınıflandırmada grupların benzer özelliklerinin belirlenmesi/ifade edilmesi/tartışılması istenir Bilinen bir sınıflandırmada grupları birbirinden ayıran özelliklerin ifade edilmesi/belirlenmesi/tartışılması istenir
	Üst-düzey işlem	SZU	Öğrenciden kendisinin belirleyeceği kıstas(lar) doğrultusunda nesne ya da olayları sınıflandırması istenir

Sınıflandırma kategorisi için örnek

> Dikkatlice incelendiğinde doğada gerçekleşen bu döngünün farklı aşamalarında suyun katı, sıvı ve gaz halini görebiliriz. Su, buharlaşırken gaz; yağmur halinde iken sıvı; kar ve dolu yağışı sırasında katı haldedir.
>
> Fen ve teknoloji derslerinde maddeyi kütlesi, hacmi ve eylemsizliği olan nesne olarak tanımlamıştık. Dünya'mızı içtiğimiz suyun, soluduğumuz havanın, üzerinde yürüdüğümüz toprağın ve daha pek çok maddenin oluşturduğunu öğrenmiştik.
>
> Dünya'daki maddelerin ortak ya da farklı özelliklere sahip olduklarını hiç düşündünüz mü?
>
> Su döngüsünde minik damlanın bazen su, bazen buhar, bazen de dolu olarak seyahat ettiğini gözlemlemişsinizdir. Acaba bu damlanın bu üç durumunda tanımlanabilecek ortak özellikler var mıdır?
>
> Ortaöğretim Fizik 9/ Sayfa 92

Sınıflandırma kategorisi örneği için açıklama: Bu bağlam biriminde (anlam bütünlüğü birden fazla paragraf ile korunmuş: P2) maddelerin hallerine göre sınıflandırılması (katı, sıvı, gaz) hakkında bilgi verildikten sonra, maddenin bu üç farklı durumunda ortak olan özellikleri sorulmuştur. Bu durumda bu kayıt birimi, sınıflandırma birimi maddelerinden SZI2 ile örtüşerek sınıflandırma birimi olarak kodlanır.

5. Tahmin Etme (T)

Tahmin etme, henüz gerçekleşmemiş bir olayın olası sonucunu, deneyime ya da verilere dayanarak öngörüde bulunmaktır. (Buxton & Provenzo, 2007). Tahmin etmeyi, çıkarım yapma becerisinden ayıran özelliği tahmin etmenin gelecekteki bir olay ile ilgili olmasıdır. Çıkarım yaparken ise gerçekleşmiş olayın sonucuna etki eden olası faktörler hakkında fikir yürütülür (Carin & Bass, 2001).

Bilimsel araştırma, sürekli bir tahmin etme ve yapılan tahmini doğrulama ya da çürütme işlemidir. Tahminler doğru, yanlış ya da eksik olabilir: olay beklendiği gibi ya da beklenenden farklı sonuçlanabilir. Bu noktada önemli olan yapılan tahminin doğru, yanlış ya da eksik olup olmadığının test edilerek öğrenilmesidir (Martin, 2006; Wolfinger, 2000).

Tahmin etme kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	TBB1	Tahmin etmenin bilimsel süreç becerisi olduğunu ifade eder
		TBB2	Bilim adamlarının çalışmalarında nesne ya da olaylar hakkında tahminlerde bulunduklarını ifade eder
	İşlemsel Bilgi	TBI1	Tahmin etme becerisi hakkında bilgi verir; verilere dayanarak nasıl tahmin yürütülebileceğini anlatır/Bir olay hakkında tahmin yapılırken dikkat edilmesi gereken hususlar hakkında bilgi verir.
Zihinsel İşlem Boyutu		TZI1	Öğrencinin gelecekteki bir olay, etkinlik ya da deneyin muhtemel sonuçları hakkında gözlem ve tecrübeye dayalı olarak tahminde bulunmasını ister.
		TZI2	Öğrenciden, değişkenler arasındaki ilişkiden yararlanarak yeni bir değişkenin olası etkilerini önceden kestirmesini ister

Tahmin etme kategorisi için örnek

Etkinlik/ Su Akışını Gözlemleme
Araç Gereçler 2 adet boş sıvı deterjan kabı, lastik hortum (15-20cm), renklendirilmiş su
Nasıl Bir Yol izleyelim? 1. Beş veya altı kişilik gruplar oluşturunuz ve aşağıdaki etkinlik basamaklarını dikkate alarak görev paylaşımı yapınız. 2. Şekildeki düzeneği kurunuz. 3. Kaplara önce farklı, sonra aynı yükseklikte su koyarak muslukları açtığınızda su akışı olup olamayacağını tartışarak bir öngörüde bulununuz. 4. Muslukları açarak su akışının olup olmadığını gözleyiniz.
Sonuca Varalım 1. Öngörünüzle gözleminiz arasında bir fark var mı? 2. Hangi durumda su akışı olmuştur ve ne zamana kadar devam etmiştir? 3. Su akışı hangi kaptan hangi kaba olmuştur?
Ortaöğretim Fizik 9/ Sayfa 182

Tahmin etme kategorisi örneği için açıklama: Yukarıdaki etkinlikte deney düzeneği kurulduktan sonra, herhangi bir işlemde bulunmadan önce yapılacak olan müdahalenin sonucuna yönelik tahminde bulunulması istenmektedir. İki kap arasındaki musluk açılmadan önce, açıldığında kaplar arasında su akışı olup olmayacağının tahmin edilmesi beklenmektedir. Bir sonraki adımda yapılan tahminin doğru, yanlış ya da eksik olup olmadığının anlaşılması için musluk açılıyor ve yapılan tahmin gerçekleşen sonuç ile karşılaştırılıyor. Bu durumda bu kayıt birimi, tahmin etme biriminin TZI1 maddesi ile örtüşmektedir.

6. Bilimsel İletişim Kurma (I)

İletişim kurma, düşünce ve/veya yorumların sözlü ya da yazılı şekilde başkalarına aktarılması, paylaşılmasıdır (Martin, 2006; Wolfinger, 2000). Bilimsel iletişim kurma ise, bilimsel bir çalışmanın herhangi bir bölümünün ya da hepsinin başkaları ile paylaşılması, yapılan çalışma hakkında tartışılmasıdır. Bilimsel iletişim kelimeler, tablolar, grafikler, modeller, kavram haritaları ve benzerleri gibi sembolik gösterimlerle kurulabilir. Bilimin ilerlemesi için, yapılan çalışmaların paylaşılması, sorgulanması ve analiz edilmesi büyük önem taşıdığı gibi, yapılan bir çalışmanın tekrar tekrar yapılması için de önemlidir (Buxton, & Provenzo, 2007).

Bilimsel iletişim kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	IBB1	Bilimsel iletişim kurmanın bilimsel süreç becerisi olduğunu ifade eder
		IBB2	Bilim adamlarının deney ve gözlemlerden elde etikleri verileri diğer bilim adamlarının incelemesi/ onaylaması /yeniden denemeleri için paylaştıklarını ifade eder
		IBB3	Bilimsel verilerin paylaşılması, tartışılması, sorgulanması veya analiz edilmesinin bilimin ilerlemesi için gerekli olduğunu vurgular
		IBB4	Bilimsel bilginin oluşması ve yayılmasında iletişimin etkisini vurgular
Zihinsel İşlem Boyutu		IZI1	Gözlem, elde edilen veriler, çıkarım ve/veya tahmin, hipotez, değişkenlerin nasıl kontrol edildiği, tasarlanan deneyler, ulaşılan sonuçlar, yapılan bir araştırma hakkında elde edilenlerin, düşünce ve yorumların paylaşılmasını ister Yapılan bir bilimsel çalışma, deney, gözlem vs. hakkında sunum yapılmasını ister. Yapılan bir bilimsel çalışma, deney, gözlem vs. hakkında rapor hazırlanmasını ister.

Bilimsel iletişim kurma kategorisi için örnek

> Araştıralım
>
> Günlük hayatta kullandığımız elektrikli ısıtıcılar, ayarlı masa lambalarının işlevleri genellikle bir düğme ile kontrol edilebilmektedir. Bu düğmenin nasıl çalıştığı ve şu ana kadar öğrendiğiniz devre elemanlarından hangi elemanla eşleşebileceği konusunda bir araştırma yapınız. Araştırmanızı yaparken elektronik tamircilerinden, elektrik ve fizik mühendislerinden, İnternetten ve konu ile ilgili yazılmış bilimsel makalelerden yararlanabilirsiniz. Elde ettiğiniz veriler doğrultusunda incelediğiniz aracın açık şemasını oluşturarak arkadaşlarınızla paylaşınız.
>
> Ortaöğretim Fizik 9/ Sayfa 190

Bilimsel iletişim kurma kategorisi örneği için açıklama: Bu bağlam biriminde öğrencilerden, elektrikli aletlerdeki düğmelerin nasıl çalıştığı hakkında bir araştırma yapmaları ve ulaştıkları bilgiler doğrultusunda incelemek istedikleri bir elektrikli aletin şemasını çizmeleri istenmektedir. Yapılan çalışmanın ve çizilen şemanın öğrenciler arasında paylaşılarak elde edilen bilgilerin öğrenciden öğrenciye aktarılması istenmiştir. Öğrencilerin kendi yaptıkları araştırma doğrultusunda ulaştıklarını bir şemada özetleyerek birbirleri ile paylaşmalarını belirten IZI1 maddesi ile örtüşür.

7. Hipotez Kurma (H)

Hipotez, değişkenler arasında öne sürülen ilişkiyi düşünce, tecrübe ve gözleme dayalı olarak açıklamaya yönelik yapılan test edilebilir önermelerdir (Martin, 2006). Problem ya da bir sorun hakkında hipotez kurulabileceği gibi bazı olay ve özellikleri ya da değişkenler arasındaki ilişkileri ortaya çıkarmak için de bir önerme ileri sürülebilir. Tahmin etme, henüz gerçekleşmemiş bir olayın olası sonucuna yönelik olmasına karşın hipotez, bağımlı değişkenin bağımsız değişken üzerine etkisinin nasıl olacağını öne süren özel bir çeşit tahmindir (Bailer, Raming, Ramsey, 1995).

Hipotez deneyin odağını belirlediği için, araştırmacıya hangi veriler üzerinde yoğunlaşması gerektiği konusunda rehberlik eder. Hipotez kurulurken önemli olan nokta doğru olması değil test edilebilir olmasıdır. Hipotez oluşturulduktan sonra, çeşitli yöntemlerle test edilerek ifadenin doğruluğu sınanmalıdır (Raming & Ramsey, 2006).

Hipotez kurma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	HBB1	Hipotez kurmanın bilimsel süreç becerisi olduğunu ifade eder
		HBB2	Bilim adamlarının çalışmalarında hipotez kurduklarını ifade eder, hipotezlerine yer verir
	İşlemsel Bilgi	HBI1	Hipotezin ne olduğu ve/veya nasıl kurulduğunu anlatır, hipotezin özelliklerinden (rasyonel olmak, açık ve işlemsel olarak tanımlanabilir olmak, sınanabilir olmak) bahseder
		HBI2	Verilen ya da kendi oluşturduğu bir hipotezin, iyi bir hipotezde olması gereken özellikler bakımından değerlendirilmesini ister
		HBI3	Bir önermenin araştırılıp araştırılmayacağının belirlenmesini ister
Zihinsel İşlem Boyutu		HZI1	Bir olayı ya da ilişkiyi açıklamak, deney ya da araştırma için test edilebilir bir hipotez kurulmasını ister

Hipotez kurma kategorisi için örnek

Bilimsel yöntem, bilimsel olarak tanımlanan problemlerin, konuyla ilgili olan diğer bilim insanlarının kabul edebileceği şekilde çözülmesi olarak tanımlanabilir. Bu şekilde, incelenen olaylarla ilgili akla uygun olan neden-sonuç ilişkileri ortaya konulmaya çalışılır. Bilimsel çalışmaları diğer çalışmalardan ayıran en önemli fark, bilimsel çalışmaların verilere dayalı olmasıdır. Bilimsel bir çalışmada en başta, incelenecek bir probleme ihtiyaç vardır. Problem belirlendikten sonra problem durumunu açıklayan verileri elde etmek için deneyler, gözlemler, inceleme ve araştırmalar yapılır. Veriler toplandıktan sonra bazı hipotezler kurulur. Peki, hipotezin ne olduğunu biliyor musunuz? Hipotez, bilimsel bir problemin verilere dayalı olarak kurulan geçici çözüm yoludur. Bilimsel bir hipotez, incelenen probleme bir ölçüde cevap verebilmeli ve eldeki tüm verileri içermelidir. Bilimsel bir hipotezin bir takım deneylerle geçerli olup olmadığı test edilebilmelidir. Bundan sonra kontrollü deneyler yapılarak hipoteze dayalı tahminlerin dolayısıyla hipotezin geçerliliği ve doğruluğu araştırılır. Bu işlem, deney sonuçlarını tahminlerle karşılaştırılarak yapılabilir. Bu kontrollü deneylerden sonra elde edilen verilerin, kurulan hipotezleri destekleyip desteklemediğine, eğer gerekiyorsa ne ölçüde desteklediğine karar verilir. Bilim insanları, çalışmaları boyunca sürekli olarak veri toplarlar ve bu verilere dayalı olarak bir takım açıklamalar yaparlar. Bilim insanları topladıkları verilere bağlı olarak inceledikleri problemi çözebilmek için önce bir dizi hipotez kurarlar. Bu hipotezler, kurulduktan sonra sürekli bir "test etme" sürecine tabi tutulur. Bu süreçte bazı hipotezler, deneysel olarak güçlü destek bulur ve önem kazanır; bazılarının da geçerli olmadığı sonucuna varılır. Ortaöğretim Fizik 9/ Sayfa 39

Hipotez kurma kategorisi örneği için açıklama: Bu bağlam biriminde (anlam bütünlüğü birden fazla paragraf ile korunmuş: P2) bilimsel yöntem ile başlayarak, hipotez kurma becerisini ve bilim adamlarının çalışmalarında sürekli olarak hipotez kurup test ettiklerini anlatılmaktadır. Bu kayıt birimi, hipotez kurma birimi maddelerinden HBB2 ve HBI1 ile örtüşerek hipotez kurma birimi olarak kodlanır.

Not: Bir bağlam birimi içerisinde, aynı kategoriye ait iki faklı kod içerebilir. Fakat bir bağlam birimi içerisinde aynı kodun tekrarlanması durumunda tekrarlanan kod sadece 1 defa kodlanır.

8. Değişkenleri Belirleme ve Kontrol Etme (B)

Değişkenleri belirleme, yapılacak deneyi etkileyebilecek bütün faktörlerin ifade edilmesidir. Değişkenleri kontrol etme ise değiştirilmesi veya sabit tutulması gereken değişkenlerin belirlenmesi ve etkisi test edilecek değişken (bağımsız değişken) haricindeki değişkenlerin sabit tutularak sadece bağımsız değişkenin değiştirilmesidir (Arthur, 1993). Deney sonucuna hangi koşulun etki ettiğini bulmak için sadece bir değişken değiştirilir (Peters, & Stout, 2006). Böylece deneyde bağımlı değişkene etki eden bağımsız değişkenin etkisi açıklanabilir.

Değişkenleri belirleme ve kontrol etme kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	BBB1	Değişkenleri belirlemenin ve/veya kontrol etmenin bilimsel süreç becerisi olduğunu ifade eder
		BBB2	Bilim adamlarının yaptıkları deneylerde aşağıdaki bilgilerden biri, bir kaçı ya da hepsine yer verir: Değişkenleri belirleyip, tanımladıkları Deney süresince değişkenleri nasıl kontrol ettikleri, Hangi değişkeni değiştirdikleri ve buna nasıl karar verdikleri Deney sonunda elde edilen bilgilerden nasıl sonuca ulaştıkları
	İşlemsel Bilgi	BBI1	Değişkenlerin nasıl belirlenmesi ve/veya kontrol edilmesi gerektiği hakkında bilgi verir
Zihinsel İşlem Boyutu		BZI1	Bir durum, olay ya da deney için aşağıdaki maddelerin birini, bir kaçını ya da hepsini yaptırır: Değişkenlerin belirlenmesi, tanımlanması Sabit tutulacak değişkenlerin belirlenmesi Bağımsız değişkenin belirlenmesi Bağımlı değişkenin belirlenmesi Kontrol edilemeyen değişkenlerin belirlenmesi Bağımsız değişkenin nasıl değiştirileceğine karar verilmesi Deney sonucunda iki değişken arasındaki ilişkinin ortaya konması Beklenmedik bir sonuca ulaştığında, neden beklendiği şekilde sonuçlanmadığını değişkenler üzerinden sorgulanması

Değişkenleri belirleme ve kontrol etme kategorisi için örnek

> Problem Çözelim
>
> Salih Can ve babası bir hafta sonu kayıkla balığa çıkarlar. Oltaları denize atar ve beklemeye başlarlar. Rüzgâr da hafif hafif esmektedir. Salih Can bir taraftan oltasıyla balık avlarken bir taraftan da dalgaları gözlemler. Dalgalar kenara yaklaştıkça dalga aralarındaki mesafenin ve dalganın azaldığını fark eder. Bu durumun nedenini babasına sorar.
>
> Sizce denizdeki dalgaların açıktan kenara yaklaştıkça hızında ve dalga boyunda meydana gelen değişimin sebebi ne olabilir?
>
> Bu problemde size göre en etkili faktör derinlik midir yoksa dalganın hızı mıdır?
>
> Değişkenleri bulalım
>
> Bağımlı değişkenler: ……………………………………………………………
> Bağımsız değişkenler: …………………………………………………………..
> Kontrol edilen değişkenler: …………………………………………………..
> Ölçüm araçları: ……………………………………………………………….
>
> Ortaöğretim Fizik 9/ Sayfa 229

Değişkenleri belirleme ve kontrol etme kategorisi örneği için açıklama: Bu bağlam biriminde yapılan bir durum tespiti için açıklama getirilmesi istenmektedir. Dalgaların arasındaki mesafenin kıyıya yaklaştıkça azalma olayının nelere bağlı olabileceği sorularak bu duruma neden olabilecek olası değişkenlerin belirlenmesi istenmektedir. İkinci soruda iki farklı değişken üzerinde düşünülmesi sağlanmaktadır. Sonrasında bağımlı, bağımsız ve kontrol edilen değişkenleri belirlenmesi istenmektedir. Bu kayıt birimi, değişkenleri belirleme ve kontrol etme birimi maddelerinden BZI1 ile örtüşmektedir.

9. Deney Tasarlama ve Yapma (D)

Deney yapma, diğer becerileri kapsayan en karmaşık beceridir. Deney yapmanın temel amacı tahmin ya da hipotezlerin sınanmasıdır: belirlenen bağımsız değişkenin bağımlı değişken üzerindeki etkisini ortaya çıkarmak için etkili planın yapılmasıdır (Martin, 2006). Deney yapma becerisi; yapılan tahmin ya da kurulan hipotez doğrultusunda uygun araç gereçleri seçme, bu araç gereçleri doğru bir şekilde kullanma, deney amacına uygun düzeneği kurma, değişkenleri kontrol ederek veriler elde etme, bu verilerle rasyonel bir sonuca vararak tahmini ya da hipotezi değerlendirme becerilerini kapsar (Settlage & Southerland, 2007). Deney yapma becerisi diğer tüm becerileri kapsadığı için ayırt etmek zor olabilir. Bu yüzden kayıt biriminde aşağıdaki koşulların her biri aranmalıdır:

- Başlamadan önce deneyin sonucuna dair tahmin yürütülmesi ya da iki değişken arasındaki ilişkiyi açıklayacak bir hipotezin kurulması

- Yapılan tahmin ya da kurulan hipotezin test edilmesi.

Deney tasarlama ve yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	DBB1	Deney yapmanın bilimsel süreç becerisi olduğunu ifade eder
		DBB2	Bilim insanlarının deney tasarladıklarını ve yaptıklarını ifade eder
		DBB3	Bilim insanlarının yaptıkları deneyleri nasıl tasarladıkları, nelere dikkat ettikleri, nasıl gerçekleştirdikleri hakkında bilgi verir
	İşlemsel Bilgi	DBI1	Deney yapma becerisi hakkında bilgi verir: deney yaparken dikkat edilmesi gereken hususlar/ Deney malzemelerini nasıl kullanılması gerektiği hakkında bilgi verir
Zihinsel İşlem Boyutu		DZI1	Öğrencilere adımları belirlenmiş bir deney, aşağıdaki koşulların hepsini sağlayacak şekilde yaptırılır; ·Deneyin sonucunu tahmin edilmesi ya da hipotez kurulmasını ister ·Deney düzeneğini öğrencinin kurmasını ister ·Verileri öğrencinin kaydetmesini ister ·Öğrencinin verileri yorumlamasını ister ·Öğrencinin deneyde elde edilen sonuç doğrultusunda tahminin ya da hipotezin doğruluğuna karar vermesini ister
	Üst-düzey işlem	DZU1	Öğrencilerden yapılacak bir deney için uygun araç gereçleri seçmesini ister, Bir hipotezi sınamak, yapılan bir tahmini test etmek, değişkenler arasındaki ilişkiyi belirlemek ya da bir soruya cevap vermek amaçlarından herhangi biri için öğrencinin özgün bir deney (düzeneğinin) tasarlamasını ister

Deney tasarlama ve yapma kategorisi için örnek

Etkinlik/ Isı ve Sıcaklığı Birbirinden ayıralım

! Etkinlikteki Bunzen bekinin kullanımı sırasında dikkatli olunuz.

Araç ve Gereçler
İki adet termometre, iki adet beherglas, iki adet ispirto ocağı, su (1,5lt), iki adet üçayak

Nasıl Bir Yol İzleyelim?

1. Beherlere biri diğerinin iki katı olacak şekilde su koyarak resimdeki düzeneği dikkatlice kurunuz.
2. Suların sıcaklıklarını ölçerek belirleyiniz.
3. Beherglaslara eşit süreyle ısı verilirse termometrelerin göstereceği değerlerin aynı olup olmayacağını tartışarak bir öngörüde bulununuz.
4. İspirto ocaklarını dikkatlice yakınız.
5. Belli aralıklarla termometrelerin gösterdiği değerleri gözlemleyerek aşağıdakine benzer bir çizelgeyi defterinize çizerek doldurunuz.

Zaman	t = 0	t	2t	3t	4t
Az olan suyun sıcaklığı					
Çok olan suyun sıcaklığı					
Verilen toplam ısı					

(Örnek çizelgedir.)

Sonuca Varalım

1. Öngörünüzle gözleminiz arasında bir fark var mı? Varsa bu farkın sebebi sizce nedir?
2. Verilen ısı miktarı aynı olmasına rağmen çizelgedeki maddelerin sıcaklık değişimi arasındaki farklılığın sebebi nedir?

Ortaöğretim Fizik 9/ Sayfa 81

Deney tasarlama ve yapma kategorisi örneği için açıklama: Bu etkinlikte öncelikle öğrencilerden deney sonucu hakkında bir tahmin yürütmeleri istenmektedir (Nasıl Bir Yol İzleyelim, 3. Madde). Deney adımlarını uygulayarak veri toplamaları, kaydetmeleri beklenmektedir (Nasıl Bir Yol izleyelim, 5. Madde). Topladıkları veriler tahminlerini sınamaları istenmektedir. Bu durumda, bu kayıt birimi deney yapma birimi maddelerinden DZI1 Maddesinin tüm koşullarını sağlayarak deney yapma birimi olarak kodlanır.

10. Veri Toplama, Yorumlama (V)

Tahmin veya hipotez ışığında nitel ve/veya nicel veri toplayabilmek, verileri çeşitli formlara (tablo, grafik, çizelge vb.) dönüştürebilmek, verileri akla uygun yorumlayarak bağımlı-bağımsız değişken arasındaki ilişkiyi belirleyebilme becerisidir (Ramign, & Ramsey, 2006; Martin, 2006; Wolfinger, 2000). Önemli olan (a) toplanan verilerin amaca uygun olması, (b) geçerli bir sonuca ulaşmak için en uygun formda düzenlenmesi, (c) veriler üzerinde düşünerek akla uygun sonuçların çıkarılmasıdır.

Veri toplama ve yorumlama kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	VBB1	Veri toplamanın, verileri sistematik bir şekilde düzenlemenin, bilgilerden arındırmanın ve/veya yorumlamanın bilimsel süreç becerisi olduğunu ifade eder
		VBB2	Bilim adamlarının düzenli bir biçimde verileri topladıkları, organize ettikleri ve/veya akla uygun bir şekilde yorumladıklarını ifade eder
		VBB3	Bilim adamlarının veri toplama ve yorumlama çalışmalarına ait detaylı örneğe yer verir (Sadece 'şu verileri toplamıştır' gibi genel cümleler değil, verilerin nasıl toplandığı, nasıl organize edildiği, bu süreçte nelere dikkat edildiği gibi detaylı bilgilerin verildiği ifadelere yer verir)
	İşlemsel Bilgi	VBI1	Veri toplama hakkında bilgi verir: Veri toplama sürecinde dikkat edilmesi gereken hususlar hakkında bilgi verir. Yapılan bir çalışmaya ait verilerin nasıl düzenlendiğiyle ilgili örnek verir
Zihinsel İşlem Boyutu		VZI1	Öğrenciden veri toplanmasını ister. Öğrenciden yaptığı gözlemde elde ettiği verileri not etmesini ister. Öğrenciden değişkenlerle yaptığı denemelerle veri toplamasını ister.
		VZI2	Toplanan verilerin düzenlenmesini ister: Verilerin, deneyin sonucunu etkilemeyecek ve/veya karışıklığa yol açacak gereksiz bilgilerden arındırılmasını ister. Herhangi bir formda (düz yazı, grafik, tablo, sütunlu grafik vb. gibi) verilen verilerin başka bir forma (düz yazı, grafik, tablo, sütunlu grafik vb. gibi) dönüştürülmesini ister.
	Üst-düzey işlem	VZU1	Verilerin yorumlanmasını ister. Verileri yorumlarken görsel formlardan (grafik, tablo, sütunlu grafik vb. gibi) faydalanılmasını ister Verilen bir görsel formu (grafik, tablo vb. gibi) yorumlamalarını ister Yapılan tahminler ile deney/gözlemde elde edilen verilerle ulaşılan sonuçların karşılaştırılmasını ister Verileri yorumlayarak bir sonuca ulaşılmasını ister
		VZU2	Öğrencilerden elde edilen sonuçların genel uygulanabilirliği hakkında varsayımda bulunmasını ister

Veri toplama ve yorumlama kategorisi için örnek

Problem Çözelim

Problem Durumu
Uğurlu beldesindeki öğrencilerin bir kısmı, beldeden geçen trenin hızının büyüklüğünü merak ediyor. Bu öğrenciler nasıl bir yöntem kullanarak trenin hızının büyüklüğünü bulabilirler?
(Bulunduğunuz yerde tren yoksa size en uygun ulaşım aracını tercih ediniz.)

Nasıl bir Yol İzleyelim?
Öncelikle trenin geçtiği doğrusal bir yol bulalım. Bu yoldan güvenli bir uzaklıkta tren yoluna paralel 50 m aralıklarla 5 öğrenci dizelim. Her birinin elinde birer kronometre olsun. Trenin lokomotifini dikkate alarak her bir öğrenci, tren birinci öğrenciye geldiğinde kronometreyi çalıştırsın ve tren kendi yanına geldiği an kronometreyi durdursun. Kronometre kullanılarak ölçülen zamanları, aşağıdakine benzer bir çizelgeyi defterinize çizerek dolduralım. Çizelgenizden yararlanarak konum-zaman grafiği çizelim.

Konum (m)	0	50	100	150	200
Zaman (s)	0				

(Örnek çizelgedir.)

Konum- zaman grafiğini çizerken zaman ölçümünden kaynaklanan hataları göz ardı etmemiz gerekmektedir.

Sonuçlandıralım
1. Buradaki öğrenciler ellerindeki verilerden yararlanarak trenin hızının büyüklüğünü nasıl belirleyebilirler? Ayrıntılı olarak yazınız ve hesaplayınız.
2. Buna benzer bir yöntemle çevrenizde başka hangi hareketlilerin hızının büyüklüğünü belirleyebilirsiniz?
3. Bu problemde trenin hızının büyüklüğünü başka hangi yöntemlerle hesaplayabilirsiniz? Yazınız.

Ortaöğretim Fizik 9/ Sayfa 138

Veri toplama ve yorumlama kategorisi örneği için açıklama: Bu kayıt biriminde öğrencilerden öncelikle örnek bir çizelge yardımıyla yaptıkları bir gözlemde topladıkları verileri çizelgede uygun yerlere yerleştirmeleri, daha sonra hazırladıkları çizelgeyi başka bir görsel forma; grafiğe dönüştürmeleri istenmektedir. 'Sonuçlandıralım' bölümünde ise öğrencilerden elde ettikleri grafikten faydalanarak bir değişkenin büyüklüğünün nasıl bulunabileceği hakkında fikir yürütmeleri istenmektedir. Bu durumda bu kayıt birimi, veri toplama ve yorumlama analiz birimi maddelerinden VZI2 maddesi ile örtüşmektedir.

11. Model Yapma (M)

Model, beş duyu organıyla algılanması mümkün olmayan nesne, kavram, olgu veya sistemin beş duyu organıyla anlaşılır ve kavranabilir somut ve görsel bir forma sokulmuş halidir. Herhangi bir obje, çizim, matematiksel eşitlik, bilgisayar programı ve benzeri şeyler model olabilir. Modeli değerli kılan, bir şeyin nasıl çalıştığının anlaşılmasına yardımcı olma özelliğidir (Wolfinger, 2000; Martin, 2006).

Model yapma kodları

	Tür	Kod	Açıklama
Bilgi Boyutu	Bilgi	MBB1	Model yapmanın bilimsel süreç becerisi olduğunu ifade eder
		MBB2	Bilim adamlarının anlaşılması güç kavramların, nesne ve olayların modellerini yaparak anlaşılır hale getirdiklerini ifade eder
		MBB3	Bilim adamlarının yaptıkları modeller hakkında detaylı bilgi verir (Modeli kimin geliştirdiği, gerçek halini nasıl algıladığı ve gerçeği ile modeli arasındaki benzerlik ve farklılıkları hakkında bilgi verir)
	İşlemsel Bilgi	MBI1	Model yapma becerisi hakkında bilgi verir: Modelin ve/veya modellemenin ne olduğu hakkında bilgi verir Modelleme yapılırken nelere dikkat edilmesi gerektiğini ifade eder Model yapabilmek için gerçeği hakkında mümkün olduğunca fazla veri toplamanın önemli olduğunu ifade eder Verilen model ile gerçek nesne/olay arasındaki benzerlikleri vurgular Olay, nesne ya da fikirleri açıklamak için -aşağıdaki koşulları sağlayarak- model kullanılır; · Anlatılanın gerçeğinin modeli olduğunu vurgular · Gerçeği ile benzer ve farklılıkları hakkında bilgi verir
Zihinsel İşlem Boyutu		MZI1	Öğrencinin model ile gerçeği (nesne, olay, kavram, sistem vb.) arasındaki benzerliklerin ve/veya farklılıkları bulmasını ister
		MZI2	Öğrenciden daha önce yapılmış bir modeli yapmasını ister
		MZI3	Daha önce yapılmış bir modeli kullanarak olaylar ya da kavramlar arasındaki ilişkinin açıklanmasını ister
	Üst-düzey işlem	MZU1	Herhangi bir formda (örn: üç boyutlu nesne) olan nesneyi temsil edecek ya da açıklayacak başka bir forma (örn: iki boyutlu bir çizim) dönüştürülmesini ister
		MZU2	Yeni bir kavram/ olay için özgün bir modelin geliştirilmesini ister

Model yapma kategorisi için örnek

Etkinlik /Model Kuralım
Araç ve Gereçler Bir adet kapalı kutu, cetvel, hesap makinesi, milimetrik kâğıt. Nasıl Bir Yol İzleyelim? 1. Beş ya da altı kişilik gruplar oluşturunuz ve aşağıdaki etkinlik basamaklarını dikkate alarak görev paylaşımı yapınız. 2. Gruptaki arkadaşlarınızla çalışarak, size verilen kutunun içyapısının nasıl olduğuyla ilgili birtakım veriler toplamaya çalışınız. 3. Elde ettiğiniz verileri kullanarak kutunun içyapısını en iyi açıklayabilecek bir model çizimi yapınız. 4. Bu modelin verilerinizle nasıl bir ilişkisi olduğunu grup arkadaşlarınızla tartışınız. Sonuca Varalım 1. Kurduğunuz modeli, diğer grupların modelleriyle karşılaştırınız. 2. Bu modellerden hangisinin en iyi olduğunu söyleyebilir misiniz? Neden? 3. Bilim insanlarının model oluşturma süreciyle sizin model oluşturma süreciniz arasında benzerlik var mı? Ortaöğretim Fizik 9/ Sayfa 42

Model yapma kategorisi örneği için açıklama: Bu kayıt biriminde öğrencilerden üç boyutlu olan bir kutunun içyapısı hakkında veri toplamaları ve bu veriler doğrultusunda kutunun içyapısını en iyi şekilde ifade edecek bir çizim yapmaları istenmektedir (Nasıl Bir Yol İzleyelim, 2. ve 3. maddeler). Bunun yanında yapılan tüm modellerin karşılaştırılması ve en iyi çizilmiş modele karar verilmesi de istenmiştir (Sonuca Varalım, 1. ve 2. madde) . Etkinliğin son maddesinde öğrencilerden bilim adamlarının model geliştirme süreçleri ile kendilerinin bu etkinlikte yaptıklarını karşılaştırmaları istenmektedir (Sonuca Varalım, 3. madde). Bu durumda bu analiz birimi, model yapma birimi maddelerinden MZS1 ile örtüşerek model yapma birimi olarak kodlanır.

D. Analiz Kuralları

İçerik analizi çalışması yapılırken dikkate alınması gereken kurallar şöyledir;

1. Analize başlamadan önce kod rehberini, kategorilere ve tanımlara aşina oluncaya kadar okuyunuz ve inceleyiniz.

2. Analize başlamadan önce Ortaöğretim 9. Sınıf Fizik Kitabını gözden geçiriniz.

3. Analizin amacına uygun olması için belirtilen kayıt birimlerini belirtilen bağlam birimleri çerçevesinde ele alınız.

4. Bir bağlam birimi birden çok kategoriyi barındırabilecekken, bir kayıt birimi sadece bir kategoriyle eşleştirilir.

5. Bir bağlam birimi içerisinde bir kategoriye ait bir kod tekrarlanıyorsa, tekrarlanan kod sadece bir defa kodlanır.

APPENDIX L

SCIENCE PROCESS SKILLS CODE BOOK EVALUATION FORM

Bu form, bilimsel süreç becerileri kod rehberi ile ilgili görüşlerinizi belirlemek amacıyla hazırlanmıştır. Form kod rehberindeki düzen göz önünde tutularak hazırlanmıştır. 5 ana bölümden oluşmaktadır: (1) Giriş, (2) Kayıt ve Bağlam Birimleri, (3) Kategoriler, (4) Analiz Kuralları ve (5) Genel Bilgiler. İlk dört bölümde kod rehberinde aynı isimle anılan bölümler hakkında görüş ve önerileriniz sorulmaktadır, son bölüm olan Genel Bilgilerde kod rehberi hakkında genel görüş ve önerileriniz sorulmaktadır. Vermiş olduğunuz içten, doğru yanıtlar ve cevapsız madde bırakmamakta gösterdiğiniz özen, kod rehberini geliştirme süreci açısından çok önemlidir.

Yardım ve katkılarınız için çok teşekkür ederim.

Araş. Gör. Beril YILMAZ SENEM

ODTÜ, Eğitim Fakültesi, OFMAE

yberil@metu.edu.tr, Tel: 210 36 86

1. Giriş

Bu bölümde, kod rehberindeki giriş bölümü hakkında görüş ve önerileriniz sorulmaktadır. Aşağıdaki sorulara yanıtınızı Evet; "E", ya da Hayır; "H" şeklinde karşısındaki kutucuğa yazınız. Yanıtınız "H" ise, ilgili bölüme kısaca açıklama yazınız lütfen.

Sorular	Görüşünüz (E/H)	"Hayır" ise önerileriniz
1. Kod rehberinin amacı açıkça verilmiş mi?		
2. Cümleler anlaşılır mı?		
3. Kod rehberi hakkında yeterli öz bilgi verilmiş mi?		
4. Giriş kısmı yeterli mi?		

Eklemek istedikleriniz: (İstediğiniz takdirde bu formla birlikte size verilen kod rehberinin üzerine gereken düzeltmeleri yapabilirsiniz).

2. Analiz Birimleri

Bu bölümde, kod rehberindeki kayıt ve bağlam birimleri hakkında görüş ve önerileriniz sorulmaktadır. Kayıt birimi, iletişim içeriğinin belli bir kategoriye yerleştirilecek olan en küçük çözümleme birimidir. Bağlam birimi ise, kayıt birimini değerlendirmek için, içinde yer aldığı bağlamı sınırlandıran en geniş bölümdür (Tavşancıl, & Aslan, 2001).

2.A. Bağlam birimleri: Bağlam birimleri için aşağıdaki tabloyu doldurunuz lütfen. Tabloda sol tarafta yer alan sorular için tablonun altında açıklama yapılmıştır. Sorulara yanıtınızı Evet; "E", ya da Hayır; "H" şeklinde karşısındaki kutucuğa yazınız. Yanıtınızın "H" olduğu maddeler için lütfen bir sonraki bölümde (2.B.ii) açıklama yapınız.

Sorular	A	E	BB	O	P	UG	EU	T	US	PC	HG	UB	D	PK	K	S	OP	P1	P2
1.Anlamlı mı?																			
2.Büyüklüğü uygun mu?																			
3.Yanlı mı?																			
4.Anlaşılabilir mi?																			
5.Kararınız nedir?																			

Açıklamalar

1. Anlamlılık: Belirlenen bağlam birimi çalışmanın amacına uygun mu?

2. Büyüklük: Belirlenen bağlam birimi doğru bir kodlama yapılması; kayıt birimini doğru belirleyebilmek için yeterli büyüklükte mi?

3. Yanlılık: Belirlenen bağlam birimi doğru kodlama yapılması için uygun mudur?

4. Anlaşılırlık: Bağlam birimini metin içinde ayırt etmek için yapılan açıklama anlaşılır mı?

5. Kararınız nedir: Bağlam birimi kod rehberinde kalmalı mı?

Bağlam birimleri hakkında tabloda 'H' olarak işaretlediklerinizi, ilgili kutucuğu belirterek (Örneğin, P bağlam biriminde 4. Anlaşılabilirdik maddesini belirtmek için; 4-P şeklinde belirtiniz) açıklayınız ve uygunsuzluğu gidermek için önerilerinizi yazınız lütfen.

2. B. Kayıt birimleri: Aşağıdaki sorulara yanıtınızı Evet; “E”, ya da Hayır; “H” şeklinde karşısındaki kutucuğa yazınız. Yanıtınız “H” ise ilgili bölüme kısaca açıklama yazınız lütfen.

Sorular	Görüşünüz (E/H)	“Hayır” ise önerileriniz
1. Kayıt birimleri araştırma probleminin gereklerini karşılar mı?		
2. Kayıt birimleri çalışmanın amacı için anlamlı mı?		
3. Kayıt birimlerinin sınırları net mi?		
4. Seçilen kayıt birimleri içerik analizi için uygulanabilir mi?		

2.C. Kod rehberinde belirlenmiş olan kayıt ve bağlam birimleri hakkında eklemek istediklerinizi lütfen aşağıda bırakılan boşluğa yazınız.

3. Kategoriler

3.A. Bu bölümde, kod rehberinde tanımlanan bilimsel süreç becerileri kategorileri hakkında görüş ve önerileriniz sorulmaktadır. Aşağıdaki sorulara yanıtlarınızı Evet; "E" ya da Hayır "H" şeklinde sorunun karşısındaki kategori ile ilgili kutucuğa yazınız. "H" olan yanıtlarınız için gerekli açıklamayı bir sonraki bölümde verilen boşluğa yapınız	Gözlem Y.	Ölçme	Çıkarım Y.	Sınıflandr.	Tahmin E.	İletişim K.	Hipotez K.	Değişkn. B. K. E.	Deney T.ve Y.	Veri T.ve Y.	Model Y.
1. Kategori için yapılan tanım anlaşılır mı?											
2. Kategori çalışmanın amacına uygun mu?											
3. Kategorinin sınırları net mi?											
4. Kategori diğer kategorilerden bağımsız mı; bir maddenin bu kategoriye yerleştirilmesi başka bir maddenin yerleştirilmesini *etkilememekte* midir?											
5. Kategori homojen mi; kategori farklı bir sınıflandırma *içermemekte* midir?											
6. Kategori bütünsel mi; kategori sınıflandırmanın bütün boyutlarını içerecek şekilde kapsamlı mı?											
7. Ayırt edici mi; herhangi bir madde, yalnızca bu kategoriye yerleştirilebilir mi?											
8. Objektif mi; farklı kodlayıcılarla aynı öğe bu kategoriye yerleştirilir mi?											
9. Kategori için verilen örnek uygun mu? (Örnek, kategori ile örtüşüyor mu?)											
10. Verilen örnekte yapılan kodlama doğru mu?											
11. Örnekte yapılan kodlamaya ilişkin açıklama anlaşılır mı?											
12. Örnekte yapılan kodlamaya ilişkin açıklama doğru mu?											

3.A.i. Bu bölümde, yukarıdaki tabloda verdiğiniz “H” yanıtları için gerekli açıklamayı soru numarası ve kategori ismi vererek (Örneğin; 7-Ölçme şeklinde) yapınız.

3.B. Bu bölümde kod rehberindeki kategorilere ait kodlar hakkındaki görüş ve önerileriniz sorulmaktadır. Sorulara vereceğiniz yanıtlarda ilgili kutucuğa Evet için "E", Hayır için "H" yazınız.

	Gözlem Yapma				Ölçme			
	GB K1	GB K2	GBI 1	GZI 1	OB B1	OB B2	OBI 1	OZ I 1
1. Kod için belirtilen boyut doğru mu?								
2. Kod için belirtilen tür doğru mu?								
3. Kod çalışmanın amacına uygun mu?								
4. Kod anlaşılır mı?								
5. Kodun sınırları belirli ve net mi?								
6. Kod, bulunduğu boyut ve tür göz önünde tutularak kapsaması gerekenleri içeriyor mu?								
7. Kod, rehberdeki başka bir kodla çakışıyor mu? Yanıtınız Evet ise hangi kod ile çakışıyor?								
8. Kodun yeniden düzenlenmesi gerekir mi?								

	Çıkarım Yapma				Sınıflandırma					
	CB B1	CB B2	CB I1	CZ I1	SB B1	SB B2	SB I1	SZ I1	SZ I2	SZ U1
1. Kod için belirtilen boyut doğru mu?										
2. Kod için belirtilen tür doğru mu?										
3. Kod çalışmanın amacına uygun mu?										
4. Kod anlaşılır mı?										
5. Kodun sınırları belirli ve net mi?										
6. Kod, bulunduğu boyut ve tür göz önünde tutularak kapsaması gerekenleri içeriyor mu?										
7. Kod, rehberdeki başka bir kodla çakışıyor mu? Yanıtınız Evet ise hangi kod ile çakışıyor?										
8. Kodun yeniden düzenlenmesi gerekir mi?										

3.B.i. Bu bölümde, yukarıdaki tabloda ilk 6 soruya verdiğiniz “H” yanıtları ve 7. ve 8. Soruya verdiğiniz “E” yanıtları için gerekli açıklamayı soru numarası ve kod ismi vererek (Örneğin; 5-OZI1) yapınız.

3.B.(Devamı) Bu bölümde kod rehberindeki kategorilere ait kodlar hakkındaki görüş ve önerileriniz sorulmaktadır. Sorulara vereceğiniz yanıtlarda ilgili kutucuğa Evet için "E", Hayır için "H" yazınız.

	Tahmin Etme					İletişim Kurma				
	TB B1	TB B2	TB I1	TZ I1	TZI 2	IB B1	IB B2	IB B3	IB B4	IZI 1
1. Kod için belirtilen boyut doğru mu?										
2. Kod için belirtilen tür doğru mu?										
3. Kod çalışmanın amacına uygun mu?										
4. Kod anlaşılır mı?										
5. Kodun sınırları belirli ve net mi?										
6. Kod, bulunduğu boyut ve tür göz önünde tutularak kapsaması gerekenleri içeriyor mu?										
7. Kod, rehberdeki başka bir kodla çakışıyor mu? Yanıtınız Evet ise hangi kod ile çakışıyor?										
8. Kodun yeniden düzenlenmesi gerekir mi?										

	Hipotez Kurma						Değişkenleri Belirleme Kontrol Etme			
	HB B1	HB B2	HB I1	HB I2	HB I3	HZ I1	BB B1	BB B2	BB I1	BZ I1
1. Kod için belirtilen boyut doğru mu?										
2. Kod için belirtilen tür doğru mu?										
3. Kod çalışmanın amacına uygun mu?										
4. Kod anlaşılır mı?										
5. Kodun sınırları belirli ve net mi?										
6. Kod, bulunduğu boyut ve tür göz önünde tutularak kapsaması gerekenleri içeriyor mu?										
7. Kod, rehberdeki başka bir kodla çakışıyor mu? Yanıtınız Evet ise hangi kod ile çakışıyor?										
8. Kodun yeniden düzenlenmesi gerekir mi?										

3.B.i. Bu . Bu bölümde, yukarıdaki tabloda ilk 6 soruya verdiğiniz “H” yanıtları ve 7. ve 8. Soruya verdiğiniz “E” yanıtları için gerekli açıklamayı soru numarası ve kod ismi vererek (Örneğin; 5-; HBB2) yapınız.

3.B.(Devamı) Bu bölümde kod rehberindeki kategorilere ait kodlar hakkındaki görüş ve önerileriniz sorulmaktadır. Sorulara vereceğiniz yanıtlarda ilgili kutucuğa Evet için "E", Hayır için "H" yazınız.

	Deney Tasarlama ve Yapma					
	DBB1	DBB2	DBB3	DBI1	DZI1	DZS1
1. Kod için belirtilen boyut doğru mu?						
2. Kod için belirtilen tür doğru mu?						
3. Kod çalışmanın amacına uygun mu?						
4. Kod anlaşılır mı?						
5. Kodun sınırları belirli ve net mi?						
6. Kod, bulunduğu boyut ve tür göz önünde tutularak kapsaması gerekenleri içeriyor mu?						
7. Kod, rehberdeki başka bir kodla çakışıyor mu? Yanıtınız Evet ise hangi kod ile çakışıyor?						
8. Kodun yeniden düzenlenmesi gerekir mi?						

	Veri Toplama ve Yorumlama							
	VB B1	VB B2	VB B3	VB I1	VZ I1	VZ I2	VZ S1	VZ S2
1. Kod için belirtilen boyut doğru mu?								
2. Kod için belirtilen tür doğru mu?								
3. Kod çalışmanın amacına uygun mu?								
4. Kod anlaşılır mı?								
5. Kodun sınırları belirli ve net mi?								
6. Kod, bulunduğu boyut ve tür göz önünde tutularak kapsaması gerekenleri içeriyor mu?								
7. Kod, rehberdeki başka bir kodla çakışıyor mu? Yanıtınız Evet ise hangi kod ile çakışıyor?								
8. Kodun yeniden düzenlenmesi gerekir mi?								

3.B.(Devamı) Bu bölümde kod rehberindeki kategorilere ait kodlar hakkındaki görüş ve önerileriniz sorulmaktadır. Sorulara vereceğiniz yanıtlarda ilgili kutucuğa Evet için "E", Hayır için "H" yazınız.

	Model Yapma								
	MB B1	MB B2	MB B3	MB I1	MZ I1	MZ I2	MZ I3	MZ S1	MZ S2
1. Kod için belirtilen boyut doğru mu?									
2. Kod için belirtilen tür doğru mu?									
3. Kod çalışmanın amacına uygun mu?									
4. Kod anlaşılır mı?									
5. Kodun sınırları belirli ve net mi?									
6. Kod, bulunduğu boyut ve tür göz önünde tutularak kapsaması gerekenleri içeriyor mu?									
7. Kod, rehberdeki başka bir kodla çakışıyor mu? Yanıtınız Evet ise hangi kod ile çakışıyor?									
8. Kodun yeniden düzenlenmesi gerekir mi?									

3.B.i. Bu bölümde, yukarıdaki tabloda ilk 6 soruya verdiğiniz “H” yanıtları ve 7. ve 8. Soruya verdiğiniz “E” yanıtları için gerekli açıklamayı soru numarası ve kod ismi vererek (Örneğin; 5-; VZI1) yapınız.

4. Analiz Kuralları

4.A. Aşağıda, kod rehberi analiz kuralları 1’den 5’e kadar sıralanmıştır. Birinci sütunda analiz kuralları hakkında sorular yer almaktadır. Sorulara yanıtınız Evet ise “E”, Hayır ise “H” harfini ilgili kutucuğa yazınız. Yanıtınız “H” ise, ilgili bölüme kısaca açıklama yazınız lütfen. Sorularla ilgili açıklamalara tablonun altında yer verilmiştir.

Sorular	1	2	3	4	5	“Hayır” ise önerileriniz
1. Anlaşılır mı?						
2. Açık mı?						
3. Anlamlı mı?						
4. Kararınız?						

1. Kural anlaşılır mı?
2. Kural açık ve net bir şekilde ifade edilmiş mi?
3. Kural, çalışma için anlamlı mı?
4. Kural kod rehberinde kalmalı mı?

4.B. Eklemek istediğiniz ya da önereceğiniz -kodlama sürecini kolaylaştıracak ve bu süreç için önemli olduğunu düşündüğünüz kural ya da madde varsa yazınız lütfen.

5. Genel Değerlendirme

5.A. Kod rehberini genel hatları ile düşünerek aşağıdaki sorulara yanıtınız Evet ise "E", Hayır ise "H" harfini ilgili kutucuğa yazınız.

Genel Sorular	Görüşünüz (E/H)
1. Kod rehberindeki bölümlerin yeri ve sıralaması anlamlı mı?	
2. Kod rehberi anlaşılır mı?	
3. Kod rehberinde sayfa düzeni uygun mu?	
4. Kod rehberi çalışmanın amacına uygun mu?	
5. Kod rehberi genel olarak dilbilgisi ve yazım kurallarına uyuyor mu?	

5. A.i. Eğer yukarıdaki tabloda herhangi bir bölümü "H" olarak işaretlediyseniz, lütfen nedeni ile birlikte açıklama yapınız. Gerekli bilgiyi kod rehberi üzerinde veya aşağıda bırakılan boşluğa lütfen yazınız.

5.B. Kod rehberini daha iyi ve anlaşılır hale getirmek için önerileriniz var ise aşağıda bırakılan boşluğa lütfen yazınız.

APPENDIX M

EVALUATION OF EXPERTS' OPINION

Science Process Skills Codebook is evaluated by nine experts by filling the expert opinion form. The responses of experts for each question are summarized in tables. In addition to the responses, suggestions of experts with the frequencies are given after the tables.

1. Introduction

Question	Answer	# of Response
1. Is the aim of the code book stated clearly?	Y N P NA	7 1 1 -
2. Are the sentences understandable?	Y N P NA	8 1 - -
3. Is there enough information about code book?	Y N P NA	7 1 1 -
4. Is the introduction part sufficient?	Y N P NA	4 3 2 -

(Note that: Y; Yes, N; No, P; Partial, NA; Not Applicable)

Experts suggest to,

- Include a paragraph mentioning how to use the codebook (1 expert).
- Write about what the codebook can and cannot be used for (1 expert).
- Elaborate the purpose of the study (1 expert).
- Highlight importance of science process skills (3 experts).

- Give detailed information about content analysis (2 experts).
- Emphasize the relation between science process skills and content analysis (2 experts).
- Include information about who can use it (1 expert).
- Include information about the duration of the application of the codebook (1 expert).

2. Unit of Analysis

2.A. Context Units

Question	Answer	Number of Response																		
		A	E	BB	O	P	UG	EU	T	US	PC	HG	UB	D	PK	K	S	OP	P1	P2
1. Is it meaningful?	Y	9	8	8	9	9	8	9	9	9	9	9	9	8	9	8	8	8	7	7
	N	-	-	1	-	-	1		-					1		-	1	1		2
	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-
	NA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								-		-	-	-	-		-				-	
2. Is size of suitable?	Y	8	8	8	9	9	8		9					8		9	8	8	8	8
	N	1	-	1	-	-		9	-	9	9	9	9		9	-	1			1
	P	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	1	1	-
	NA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
							-	-		-	-	-	-	-	-			-	-	
3. Is it tendentious? *	Y	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	1	1	-	-
	N	6	5	5	6	6		6	6	6	6	6	6		6	6	5		5	5
	P	-	-	-	-	-	5	-	-	-	-	-	-	5	-	-	-	5	-	-
	NA	3	4		3	3	-	3	3	3	3	3	3	-	3	3	3	-	4	4
				3			3							3				3		
4. Is it understandable?	Y	9	8	8	9	9	8		9					8		9	8	8	6	6
	N	-	-	1	-	-		9	-	9	9	9	9		9	-	1			3
	P	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	1	3	-
	NA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
							-	-		-	-	-	-	-	-			-	-	
5. What is your decision?	Y	9	8	8	9	9	8	9	9	9	9	9	9	8	9	8	8	8	8	7
	N	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	1	1	1	2
	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

(Note that: Y; Yes, N; No, P; Partial, NA; Not Applicable)

- Experts suggest taking into account P1 and P2; need to elaborate the definition of paragraph. Make clear the distinction between two of them or combine them (3 experts).

2.B. Unit of Record

Question	Answer	# of Response
1. Do recording units correspond to the requirements of the research problem?	Y H P NA	7 1 - 1
2. Do recording units meaningful for the research purpose?	Y H P NA	6 1 1 1
3. Are the limits of recording units clear enough?	Y H P NA	5 2 2 -
4. Do the selected recording units applicable for the content analyses?	Y H P NA	7 1 1 -

Experts suggest to,

- First three units of records are enough for the analysis (1 expert).
- Mention also purpose of the study in this part (1 expert).
- Make clear how to take into account the sentences as a unit of record; basic or complex (1 expert)?
- Table is not a unit of record unless students aren't asked to fill it (1 expert).
- Rethink about the activities as o unit of record, each step may go different SPS. Each step can be thought as a separate unit of record (1 expert).
- Unit of records can be written for each context units (1 expert).

(Note that: Y; Yes, N; No, P; Partial, NA; Not Applicable)

3. Categories

3.A. General Evaluation of Categories	Answer	1. Observation	2. Measurement	3. Interpretation	4. Classification	5. Prediction	6. Communication	7. Hypothesizing	8. Determination & Control of Var.	9. Design and Make Experiment	10.Collecting and Interpreting Data	11.Modeling
1. Is description for category understandable?	Y N	7 -	7 -	7 -	7 -	7 -	7 -	7 -	7 -	7 -	7 -	7 -
2. Is category suitable for the research purpose?	Y N	7 -	7 -	7 -	7 -	7 -	7 -	7 -	7 -	7 -	7 -	7 -
3. Are the limits of the category clear?	Y N	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -
4. Is the category independent from other categories?	Y N	5 1	5 1	6 -	6 -	6 -	5 1	5 1	5 1	5 1	5 1	5 1
5. Is category homogeneous; category is “not involving” another categorization?	Y N	5 1	5 1	6 -	6 -	6 -	5 1	5 1	5 1	5 1	5 1	5 1
6. Is the scope of the category holistic; is it holistic enough to include all data belongs to this category?	Y N	5 1	5 1	5 1	5 1	5 1	5 1	5 1	5 1	5 1	5 1	5 1
7. Is it distinguishing; can any item be coded only in this category?	Y N	5 -	5 -	5 -	5 -	5 -	5 -	5 -	5 -	5 -	5 -	 5 -
8. Is it objective, is it placed in the same category by different coders?	Y N	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -
9. Is example suitable for category? (Is example fits to category?)	Y N	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -
10. Is coding shown in the example correct?	Y N	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	5 1	6 -	5 1
11. Is explanation shown in the example understandable?	Y N	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6 -	5 1	5 1	5 1
12. Is explanation for coding shown in the example correct?	Y N	6 -	6 -	6 -	6 -	6 -	6 -	6 -	6-	5 1	6 -	5 1

Experts suggest to,

- Divide the SPS into two main part as Basic SPS and Experimental SPS (1 expert).
- Elaborate definition of the category “Designing and Performing Experiment” in order to prevent misconceptions about experimenting (1 expert).
- Revise definition of Modeling; delete the part “difficult to understand” from the definition. Because it is always possible to model anything, not need to be complicated (1 expert).
- Add examples from different unit of records except from activities (2 experts).
- Add examples for the knowledge level of the categories (2 experts).
- Be careful while coding the activities! (1 expert)

3.B. Evaluation of Codes

Experts suggest to

- Revise the explanation for the code MBB3; keeping in mind that there can be more than one models of anything whose real structure hasn’t discovered totally (1 expert).
- Rethink about the codes HBI1, 2, 3; elaborate the definitions (1 expert).
- Make clear the difference between the codes IBB3 and IBB 4 (1 expert).
- Add “find the tested hypothesis in the experiment or activity” for hypothesizing category (1 expert).
- Think about to combine the codes for information level (1 expert).

4. Rules of Analysis

Question	Answer	# of Response				
		1	2	3	4	5
1. Is the rule understandable?	Y H P NA	7 - - 2	5 1 - 3	5 1 - 3	7 - - 2	6 - - 3
2. Is the rule clearly stated?	Y N P NA	7 - - 2	4 2 - 3	3 3 - 3	5 1 - 3	5 1 - 3
3. Is the rule meaningful for the study?	Y N P NA	6 - - 3	4 - - 5	4 - - 5	5 - - 4	5 - - 4
4. Should the rule remain in the code book?	Y N P NA	7 - - 2	4 - - 5	5 - - 4	6 - - 3	5 - - 4

Experts suggest to

- Make clear the verb "review" (3 experts).
- Change the step 4 (2 experts).
- Explain how to handle the overcoming codes (1 expert).

(Note that: Y; Yes, N; No, P; Partial, NA; Not Applicable)

5. General Evaluation

Question	Answer	# of Response
1. Are the locations and orders of the sections meaningful?	Y N P NA	7 - 1 1
2. Is code book understandable?	Y N P NA	7 - 1 1
3. Is the page layout of the code book appropriate?	Y N P NA	7 - 1 1
4. Is the code book suitable for the purpose of the study?	Y N P NA	8 - - 1
5. Is the grammar and orthography of the code book correct?	Y N P NA	7 - 1 1

(Note that: Y; Yes, N; No, P; Partial, NA; Not Applicable)

Experts suggest to

- Not give the references in the paragraph, give them as footnote (1 expert).
- Avoid repeating the same concepts (1expert).
- Make some explanations shorter (1 expert).
- Explanations and examples in the codebook can be written in different color or with different background (1 expert).
- Find patient coders and train them since the codebook needs attention and time in order to attain reliable findings (1 expert).
- Put the rules of analysis before the categories (1 expert)

APPENDIX N

FINDINGS OF CURRICULUM AFTER FIRST CODING PROCESS

	Code	Source	Reference	Domain	Dimension	Total
1 Measuring	SKD1	0	0	Declarative	Knowledge-Based	Source Reference
	SKD2	2	2	Source Reference	Source Reference	
	SKD3	1	1	12 13		
	SKD4	10	10			
	SKP1	0	0	Procedural	14 18	
	SKP2	5	5	Source Reference		19 40
	SKP3	0	0	5 5		
	SSTP	0	0	Task-Based	Skill-Based	
	SSTM	1	1	Source Reference	Source Reference	
	SSTMP	9	21	9 22	9 22	

	Code	Source	Reference	Domain	Dimension	Total
2 Collecting and Analyzing Data	DKD1	0	0	Declarative	Knowledge-Based	Source Reference
	DKD2	2	2	Source Reference	Source Reference	
	DKD3	0	0	2 2		
	DKP1	0	0	Procedural	2 2	
	DKP2	0	0	Source Reference		
	DKP3	0	0	0 0		8 36
	DSTP	0	0	Task-Based	Skill-Based	
	DSTM	7	16	S 7 R 16	Source Reference	
	DSR1	6	18	Transferable	7 34	
	DSR2	0	0	S 6 R 18		

	Code	Source	Reference	Domain	Dimension	Total
3 Classifying	LKD1	0	0	Declarative	Knowledge-Based	Source Reference
	LKD2	2	2	Source Reference	Source Reference	
	LKD3	0	0	2 2		
	LKD4	0	0			
	LKP1	0	0	Procedural	2 2	
	LKP2	0	0	Source Reference		14 32
	LKP3	0	0	0 0		
	LSTM1	8	17	Task-Based	Skill-Based	
	LSTM2	7	13	S 13 R 30	Source Reference	
	LSRM	0	0	Transferable S 0 R 0	13 30	

		Code	Source	Reference	Domain		Dimension		Total	
4	Experimenting	EKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		EKD2	2	3	Source	Reference	Source	Reference		
		EKD3	1	2	2	5				
		EKP1	0	0	Procedural		4	7		
		EKP2	2	2	Source	Reference			11	24
		EKP3	0	0	2	2				
		ESTP	0	0	Task-Based		Skill-Based			
		ESTM	0	0	Source	Reference	Source	Reference		
		ESTMP	8	17	8	17	8	17		

		Code	Source	Reference	Domain		Dimension		Total	
5	Modeling	MKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		MKD2	2	2	Source	Reference	Source	Reference		
		MKD3	1	2	3	4				
		MKP1	0	0	Procedural		3	4		
		MKP2	0	0	Source	Reference			8	17
		MKP3	0	0	0	0				
		MSTP	0	0	Task-Based		Skill-Based			
		MSTM	0	0	Source	Reference	Source	Reference		
		MSTMP	6	13	6	13	6	13		

		Code	Source	Reference	Domain		Dimension		Total	
6	Defining and Controlling Variables	VKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		VKD2	2	2	Source	Reference	Source	Reference		
		VKD3	0	0	2	2				
		VKP1	0	0	Procedural		2	2		
		VKP2	0	0	Source	Reference				
		VKP3	0	0	0	0			6	16
		VSTP	0	0	Task-Based		Skill-Based			
		VSTM1	0	0	Source	Reference	Source	Reference		
		VSTM2	0	0	4	14	4	14		
		VSTMP	4	14						

		Code	Source	Reference	Domain		Dimension		Total	
7	Hypothesizing	HKD1	1	1	Declarative		Knowledge-Based		Source	Reference
		HKD2	2	2	Source	Reference	Source	Reference		
		HKD3	0	0	2	3				
		HKP1	0	0	Procedural		2	3		
		HKP2	0	0	Source	Reference			4	11
		HKP3	0	0	0	0				
		HSTM1	0	0	Task-Based		Skill-Based			
		HSTM2	3	8	Source	Reference	Source	Reference		
					3	8	3	8		

No.	Skill	Code	Source	Reference	Domain		Dimension		Total	
8	Observing									
		OKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		OKD2	2	2	Source	Reference	Source	Reference		
		OKD3	1	1	2	3				
		OKP1	1	1	Procedural		3	5		
		OKP2	0	0	Source	Reference			4	7
		OKP3	1	1	2	2				
		OSTP	0	0	Task-Based		Skill-Based			
		OSTM	1	1	Source	Reference	Source	Reference		
		OSTMP	1	1	2	2	2	2		

No.	Skill	Code	Source	Reference	Domain		Dimension		Total	
9	Communicating Scientifically									
		CKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		CKD2	2	2	Source	Reference	Source	Reference		
		CKD3	1	1	3	3				
		CKP1	0	0	Procedural		3	3		
		CKP2	0	0	Source	Reference			3	3
		CKP3	0	0	0	0				
		CSTP	0	0	Task-Based		Skill-Based			
		CSTM	0	0	Source	Reference	Source	Reference		
		CSTMP	0	0	0	0	0	0		

No.	Skill	Code	Source	Reference	Domain		Dimension		Total	
10	Inferring									
		IKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		IKD2	2	2	Source	Reference	Source	Reference		
		IKD3	0	0	2	2				
		IKP1	0	0	Procedural		2	2		
		IKP2	0	0	Source	Reference			2	2
		IKP3	0	0	0	0				
		ISTP	0	0	Task-Based		Skill-Based			
		ISTM	0	0	Source	Reference	Source	Reference		
		ISTMP	0	0	0	0	0	0		

No.	Skill	Code	Source	Reference	Domain		Dimension		Total	
11	Predicting									
		PKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		PKD2	2	2	Source	Reference	Source	Reference		
		PKD3	0	0	2	2				
		PKP1	0	0	Procedural		2	2		
		PKP2	0	0	Source	Reference			2	2
		PKP3	0	0	0	0				
		PSTM1	0	0	Task-Based		Skill-Based			
		PSTM2	0	0	Source	Reference	Source	Reference		
		PSTM3	0	0	0	0	0	0		

APPENDIX O

FINDINGS OF TEXTBOOK AFTER FIRST CODING PROCESS

No.		Code	Source	Reference	Domain		Dimension		Total	
1	Measuring	SKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		SKD2	2	2	Source	Reference	Source	Reference		
		SKD3	3	3	17	20				
		SKD4	13	15						
		SKP1	8	15	Procedural		43	74		
		SKP2	22	29	Source	Reference			68	129
		SKP3	8	10	30	54				
		SSTP	22	23	Task-Based		Skill-Based			
		SSTM	13	18	Source	Reference	Source	Reference		
		SSTMP	13	13	38	54	38	54		

No.		Code	Source	Reference	Domain		Dimension		Total	
2	Collecting and Analyzing Data	DKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		DKD2	3	4	Source	Reference	Source	Reference		
		DKD3	0	0	3	4				
		DKP1	0	0	Procedural		3	4		
		DKP2	0	0	Source	Reference				
		DKP3	0	0	0	0			53	73
		DSTP	5	5	Task-Based		Skill-Based			
		DSTM	12	12	S 17	R 17	Source	Reference		
		DSR1	41	49	Transferable		51	69		
		DSR2	3	3	S43	R 52				

No.		Code	Source	Reference	Domain		Dimension		Total	
3	Observing	OKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		OKD2	7	9	Source	Reference	Source	Reference		
		OKD3	0	0	7	9				
		OKP1	5	9	Procedural		10	18		
		OKP2	0	0	Source	Reference			56	72
		OKP3	0	0	5	9				
		OSTP	41	43	Task-Based		Skill-Based			
		OSTM	3	4	Source	Reference	Source	Reference		
		OSTMP	6	7	50	54	50	54		

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Source Reference
14 25</td><td rowspan="7">Knowledge-Based
Source Reference
14 25</td><td rowspan="10">Source Reference
32 53</td></tr>
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<tr><td>LKD4</td><td>14</td><td>25</td></tr>
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<tr><td>LKP2</td><td>0</td><td>0</td></tr>
<tr><td>LKP3</td><td>0</td><td>0</td></tr>
<tr><td>LSTM1</td><td>18</td><td>20</td><td rowspan="2">Task-Based
S 22 R 28</td><td rowspan="3">Skill-Based
Source Reference
22 28</td></tr>
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S 0 R 0</td></tr>
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Source Reference
1 1</td><td rowspan="6">Knowledge-Based
Source Reference
1 1</td><td rowspan="9">Source Referenc
42 50</td></tr>
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<tr><td>IKP1</td><td>0</td><td>0</td><td rowspan="3">Procedural
Source Reference
0 0</td></tr>
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<tr><td>IKP3</td><td>0</td><td>0</td></tr>
<tr><td>ISTP</td><td>15</td><td>17</td><td rowspan="3">Task-Based
Source Reference
41 49</td><td rowspan="3">Skill-Based
Source Reference
41 49</td></tr>
<tr><td>ISTM</td><td>1</td><td>1</td></tr>
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Source Reference
0 0</td><td rowspan="6">Knowledge-Based
Source Reference
1 1</td><td rowspan="9">Source Reference
34 38</td></tr>
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Source Reference
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<tr><td>PKP3</td><td>0</td><td>0</td></tr>
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Source Reference
34 37</td><td rowspan="3">Skill-Based
Source Reference
34 37</td></tr>
<tr><td>PSTM2</td><td>33</td><td>36</td></tr>
<tr><td>PSTM3</td><td>0</td><td>0</td></tr>
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		Code	Source	Reference	Domain		Dimension		Total	
7	Communicating Scientifically	CKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		CKD2	2	2	Source	Reference	Source	Reference		
		CKD3	0	0	2	2				
		CKP1	0	0	Procedural		2	2		
		CKP2	0	0	Source	Reference			28	28
		CKP3	0	0	0	0				
		CSTP	25	25	Task-Based		Skill-Based			
		CSTM	0	0	Source	Reference	Source	Reference		
		CSTMP	1	1	26	26	26	26		

		Code	Source	Reference	Domain		Dimension		Total	
8	Experimenting	EKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		EKD2	7	14	Source	Reference	Source	Reference		
		EKD3	2	2	7	16				
		EKP1	1	1	Procedural		13	22		
		EKP2	0	0	Source	Reference			13	22
		EKP3	5	5	6	6				
		ESTP	0	0	Task-Based		Skill-Based			
		ESTM	0	0	Source	Reference	Source	Reference		
		ESTMP	0	0	0	0	0	0		

		Code	Source	Reference	Domain		Dimension		Total	
9	Hypothesizing	HKD1	1	1	Declarative		Knowledge-Based		Source	Reference
		HKD2	3	6	Source	Reference	Source	Reference		
		HKD3	1	1	3	8				
		HKP1	1	1	Procedural		4	10		
		HKP2	1	1	Source	Reference			6	13
		HKP3	0	0	2	2				
		HSTM1	0	0	Task-Based		Skill-Based			
		HSTM2	3	3	Source	Reference	Source	Reference		
					3	3	3	3		

		Code	Source	Reference	Domain		Dimension		Total	
10	Modeling	MKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		MKD2	1	2	Source	Reference	Source	Reference		
		MKD3	2	3	2	5				
		MKP1	0	0	Procedural		3	8		
		MKP2	1	1	Source	Reference			5	12
		MKP3	2	2	2	3				
		MSTP	1	1	Task-Based		Skill-Based			
		MSTM	1	1	Source	Reference	Source	Reference		
		MSTMP	2	2	3	4	3	4		

		Code	Source	Reference	Domain		Dimension		Total	
11	Defining and Controlling Variables	VKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		VKD2	1	1	Source	Reference	Source	Referenc		
		VKD3	0	0	1	1				
		VKP1	0	0	Procedural		1	1		
		VKP2	0	0	Source	Reference			11	11
		VKP3	0	0	0	0				
		VSTP	1	1	Task-Based		Skill-Based			
		VSTM1	9	9	Source	Reference	Source	Referenc		
		VSTM2	0	0	10	10	10	10		
		VSTMP	0	0						

APPENDIX P

FINDINGS OF CURRICULUM AFTER LAST CODING PROCESS

1	Collecting and Analyzing Data	Code	Source	Reference	Domain		Dimension		Total	
		DKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		DKD2	1	1	Source	Reference	Source	Reference		
		DKD3	0	0	1	1				
		DKP1	0	0	Procedural		1	1		
		DKP2	0	0	Source	Reference				
		DKP3	0	0	0	0			18	58
		DSTP	2	2	Task-Based		Skill-Based			
		DSTM	9	17	11	32	Source	Reference		
		DSR1	8	10	Transferable		17	57		
		DSR2	13	28	15	57				

2	Communicating Scientifically	Code	Source	Reference	Domain		Dimension		Total	
		CKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		CKD2	1	1	Source	Reference	Source	Reference		
		CKD3	0	0	1	1				
		CKP1	0	0	Procedural		1	1		
		CKP2	0	0	Source	Reference			13	40
		CKP3	0	0	0	0				
		CSTP	2	5	Task-Based		Skill-Based			
		CSTM	4	5	Source	Reference	Source	Reference		
		CSTMP	9	29	12	39	12	39		

3	Measuring	Code	Source	Reference	Domain		Dimension		Total	
		SKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		SKD2	1	1	Source	Reference	Source	Reference		
		SKD3	0	0	10	10				
		SKD4	9	9						
		SKP1	0	0	Procedural		14	15		
		SKP2	5	5	Source	Reference			19	33
		SKP3	0	0	5	5				
		SSTP	0	0	Task-Based		Skill-Based			
		SSTM	0	0	Source	Reference	Source	Reference		
		SSTMP	9	18	9	18	9	18		

		Code	Source	Reference	Domain	Dimension	Total
4	Experimenting	EKD1	0	0	Declarative	Knowledge-Based	Source Reference
		EKD2	1	1	Source Reference	Source Reference	
		EKD3	1	1	2 2		
		EKP1	0	0	Procedural	5 6	
		EKP2	4	4	Source Reference		15 32
		EKP3	0	0	3 4		
		ESTP	0	0	Task-Based	Skill-Based	
		ESTM	0	0	Source Reference	Source Reference	
		ESTMP	12	26	12 26	12 26	

		Code	Source	Reference	Domain	Dimension	Total
5	Classifying	LKD1	0	0	Declarative	Knowledge-Based	Source Reference
		LKD2	1	1	Source Reference	Source Reference	
		LKD3	0	0	1 1		
		LKD4	0	0			
		LKP1	0	0	Procedural	1 1	
		LKP2	0	0	Source Reference		14 27
		LKP3	0	0	0 0		
		LSTM1	9	16	Task-Based	Skill-Based	
		LSTM2	7	10	S 13 R 26	Source Reference	
		LSRM	0	0	Transferable S 0 R 0	13 26	

		Code	Source	Reference	Domain	Dimension	Total
6	Modeling	MKD1	0	0	Declarative	Knowledge-Based	Source Reference
		MKD2	1	1	Source Reference	Source Reference	
		MKD3	1	3			
		MKD4	0	0	2 4		
		MKP1	0	0	Procedural	2 4	
		MKP2	0	0	Source Reference		14 22
		MKP3	0	0	0 0		
		MSTP	1	1	Task-Based	Skill-Based	
		MSTM	11	14	Source Reference	Source Reference	
		MSTMP	3	3	12 18	12 18	

<table>
<tr><td rowspan="9">7</td><td rowspan="9">Hypothesizing</td><td>Code</td><td>Source</td><td>Reference</td><td>Domain</td><td>Dimension</td><td>Total</td></tr>
<tr><td>HKD1</td><td>1</td><td>1</td><td rowspan="3">Declarative
Source Reference
1 2</td><td rowspan="6">Knowledge-Based
Source Reference
1 2</td><td rowspan="8">Source Reference
9 20</td></tr>
<tr><td>HKD2</td><td>1</td><td>1</td></tr>
<tr><td>HKD3</td><td>0</td><td>0</td></tr>
<tr><td>HKP1</td><td>0</td><td>0</td><td rowspan="3">Procedural
Source Reference
0 0</td></tr>
<tr><td>HKP2</td><td>0</td><td>0</td></tr>
<tr><td>HKP3</td><td>0</td><td>0</td></tr>
<tr><td>HSTM1</td><td>0</td><td>0</td><td rowspan="2">Task-Based
Source Reference
8 18</td><td rowspan="2">Skill-Based
Source Reference
8 18</td></tr>
<tr><td>HSTM2</td><td>8</td><td>18</td></tr>
</table>

<table>
<tr><td rowspan="11">8</td><td rowspan="11">Defining and Controlling Variables</td><td>Code</td><td>Source</td><td>Reference</td><td>Domain</td><td>Dimension</td><td>Total</td></tr>
<tr><td>VKD1</td><td>0</td><td>0</td><td rowspan="3">Declarative
Source Reference
1 1</td><td rowspan="6">Knowledge-Based
Source Reference
1 1</td><td rowspan="10">Source Reference
7 13</td></tr>
<tr><td>VKD2</td><td>1</td><td>1</td></tr>
<tr><td>VKD3</td><td>0</td><td>0</td></tr>
<tr><td>VKP1</td><td>0</td><td>0</td><td rowspan="3">Procedural
Source Reference
0 0</td></tr>
<tr><td>VKP2</td><td>0</td><td>0</td></tr>
<tr><td>VKP3</td><td>0</td><td>0</td></tr>
<tr><td>VSTP</td><td>0</td><td>0</td><td rowspan="4">Task-Based
Source Reference
6 12</td><td rowspan="4">Skill-Based
Source Reference
6 12</td></tr>
<tr><td>VSTM1</td><td>1</td><td>1</td></tr>
<tr><td>VSTM2</td><td>0</td><td>0</td></tr>
<tr><td>VSTMP</td><td>6</td><td>11</td></tr>
</table>

<table>
<tr><td rowspan="10">9</td><td rowspan="10">Observing</td><td>Code</td><td>Source</td><td>Reference</td><td>Domain</td><td>Dimension</td><td>Total</td></tr>
<tr><td>OKD1</td><td>0</td><td>0</td><td rowspan="3">Declarative
Source Reference
2 2</td><td rowspan="6">Knowledge-Based
Source Reference
3 4</td><td rowspan="9">Source Reference
6 8</td></tr>
<tr><td>OKD2</td><td>1</td><td>1</td></tr>
<tr><td>OKD3</td><td>1</td><td>1</td></tr>
<tr><td>OKP1</td><td>1</td><td>1</td><td rowspan="3">Procedural
Source Reference
2 2</td></tr>
<tr><td>OKP2</td><td>0</td><td>0</td></tr>
<tr><td>OKP3</td><td>1</td><td>1</td></tr>
<tr><td>OSTP</td><td>0</td><td>0</td><td rowspan="3">Task-Based
Source Reference
4 4</td><td rowspan="3">Skill-Based
Source Reference
4 4</td></tr>
<tr><td>OSTM</td><td>1</td><td>1</td></tr>
<tr><td>OSTMP</td><td>3</td><td>3</td></tr>
</table>

No.	Category	Code	Source	Reference	Domain		Dimension		Total	
10	Inferring	IKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		IKD2	1	1	Source	Reference	Source	Reference		
		IKD3	0	0	1	1				
		IKP1	0	0	Procedural		1	1		
		IKP2	0	0	Source	Reference			1	1
		IKP3	0	0	0	0				
		ISTP	0	0	Task-Based		Skill-Based			
		ISTM	0	0	Source	Reference	Source	Reference		
		ISTMP	0	0	0	0	0	0		

No.	Category	Code	Source	Reference	Domain		Dimension		Total	
11	Predicting	PKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		PKD2	1	1	Source	Reference	Source	Reference		
		PKD3	0	0	1	1				
		PKP1	0	0	Procedural		1	1		
		PKP2	0	0	Source	Reference			1	1
		PKP3	0	0	0	0				
		PSTM1	0	0	Task-Based		Skill-Based			
		PSTM2	0	0	Source	Reference	Source	Reference		
		PSTM3	0	0	0	0	0	0		

APPENDIX R

FINDINGS OF TEXTBOOK AFTER LAST CODING PROCESS

No.	Theme	Code	Source	Reference	Domain		Dimension		Total	
1	Collecting and Analyzing Data	Code	Source	Reference	Domain		Dimension		Total	
		DKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		DKD2	3	4	Source	Reference	Source	Reference		
		DKD3	0	0	3	4				
		DKP1	0	0	Procedural					
		DKP2	1	1	Source	Reference	4	5		
		DKP3	0	0	1	1			119	150
		DSTP	29	29	Task-Based		Skill-Based			
		DSTM	10	11	37	40	Source	Reference		
		DSR1	65	80	Transferable		116	145		
		DSR2	22	25	84	105				

No.	Theme	Code	Source	Reference	Domain		Dimension		Total	
2	Measuring	Code	Source	Reference	Domain		Dimension		Total	
		SKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		SKD2	2	2	Source	Reference	Source	Reference		
		SKD3	4	5	21	26				
		SKD4	16	19						
		SKP1	12	20	Procedural		48	90		
		SKP2	22	33	Source	Reference			76	148
		SKP3	9	11	31	64				
		SSTP	24	25	Task-Based		Skill-Based			
		SSTM	16	21	Source	Reference	Source	Reference		
		SSTMP	11	12	44	58	44	58		

No.	Theme	Code	Source	Reference	Domain		Dimension		Total	
3	Modeling	Code	Source	Reference	Domain		Dimension		Total	
		MKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		MKD2	3	5	Source	Reference	Source	Reference		
		MKD3	2	3						
		MKD4	23	23	27	31				
		MKP1	0	0	Procedural		28	32		
		MKP2	0	0	Source	Reference			59	82
		MKP3	1	1	1	1				
		MSTP	2	3	Task-Based		Skill-Based			
		MSTM	38	44	Source	Reference	Source	Reference		
		MSTMP	3	3	43	50	43	50		

		Code	Source	Reference	Domain		Dimension		Total	
4	Classifying	LKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		LKD2	0	0	Source	Reference	Source	Reference		
		LKD3	0	0	19	42				
		LKD4	19	42						
		LKP1	0	0	Procedural		19	42		
		LKP2	0	0	Source	Reference				
		LKP3	0	0	0	0			43	79
		LSTM1	24	28	Task-Based		Skill-Based			
		LSTM2	8	9	S 30	R 37	Source	Reference		
		LSRM	0	0	Transferable		30	37		
					S 0	R 0				

		Code	Source	Reference	Domain		Dimension		Total	
5	Observing	OKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		OKD2	7	11	Source	Reference	Source	Reference		
		OKD3	0	0	7	11				
		OKP1	4	8	Procedural		10	19		
		OKP2	0	0	Source	Reference			56	75
		OKP3	0	0	4	8				
		OSTP	40	42	Task-Based		Skill-Based			
		OSTM	4	5	Source	Reference	Source	Reference		
		OSTMP	8	9	51	56	51	56		

		Code	Source	Reference	Domain		Dimension		Total	
6	Inferring	IKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		IKD2	1	1	Source	Reference	Source	Reference		
		IKD3	0	0	1	1				
		IKP1	0	0	Procedural		1	1		
		IKP2	0	0	Source	Reference			52	67
		IKP3	0	0	0	0				
		ISTP	25	28	Task-Based		Skill-Based			
		ISTM	1	1	Source	Reference	Source	Reference		
		ISTMP	32	37	51	66	51	66		

No.	Skill	Code	Source	Reference	Domain		Dimension		Total	
7	Communicating Scientifically	CKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		CKD2	1	1	Source	Reference	Source	Reference		
		CKD3	0	0	1	1				
		CKP1	0	0	Procedural		1	1		
		CKP2	0	0	Source	Reference			41	42
		CKP3	0	0	0	0				
		CSTP	39	40	Task-Based		Skill-Based			
		CSTM	0	0	Source	Reference	Source	Reference		
		CSTMP	1	1	40	41	40	41		

No.	Skill	Code	Source	Reference	Domain		Dimension		Total	
8	Predicting	PKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		PKD2	0	0	Source	Reference	Source	Reference		
		PKD3	0	0	0	0				
		PKP1	0	0	Procedural		1	1		
		PKP2	1	1	Source	Reference				
		PKP3	0	0	1	1			35	39
		PSTM1	2	2	Task-Based		Skill-Based			
		PSTM2	33	36	Source	Reference	Source	Reference		
		PSTM3	0	0	35	38	35	38		

No.	Skill	Code	Source	Reference	Domain		Dimension		Total	
9	Experimenting	EKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		EKD2	9	17	Source	Reference	Source	Reference		
		EKD3	2	3	9	20				
		EKP1	1	1	Procedural		21	32		
		EKP2	1	1	Source	Reference			21	33
		EKP3	10	10	12	12				
		ESTP	1	1	Task-Based		Skill-Based			
		ESTM	0	0	Source	Reference	Source	Reference		
		ESTMP	0	0	1	1	1	1		

		Code	Source	Reference	Domain		Dimension		Total	
10	Defining and Controlling Variables	VKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		VKD2	1	1	Source	Reference	Source	Reference		
		VKD3	0	0	1	1				
		VKP1	2	2	Procedural		3	3		
		VKP2	0	0	Source	Reference				
		VKP3	0	0	2	2			15	17
		VSTP	2	2	Task-Based		Skill-Based			
		VSTM1	12	12	Source	Reference	Source	Reference		
		VSTM2	0	0	14	14	14	14		
		VSTMP	0	0						

		Code	Source	Reference	Domain		Dimension		Total	
11	Hypothesizing	HKD1	0	0	Declarative		Knowledge-Based		Source	Reference
		HKD2	4	6	Source	Reference	Source	Reference		
		HKD3	0	0	4	6				
		HKP1	2	2	Procedural		5	8		
		HKP2	0	0	Source	Reference			7	12
		HKP3	0	0	2	2				
		HSTM1	1	1	Task-Based		Skill-Based			
		HSTM2	3	3	Source	Reference	Source	Reference		
					3	4	3	4		

APPENDIX S

ETHICAL ISSUES

ÖĞR... İŞLERİ
DAİRESİ B...KANLIĞI
Ev. Arş ... Saat :

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

Sayı : 14588481/605.99/483121 05/04/2013
Konu: Araştırma İzni
(Beril YILMAZ SENEM)

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
(Öğrenci İşleri Daire Başkanlığı)

İlgi : a) Meb Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2012/13 nolu genelgesi
b) 12/03/2013 tarih ve 1421 sayılı yazınız.

Üniversiteniz Ortaöğretim Fen ve Matematik Alanları Eğitimi Ana Bilim Dalı Doktora Programı öğrencisi Beril YILMAZ SENEM'in "Fizik Eğitiminde Bilimsel Süreç Becerileri" konulu tez önerisi kapsamında uygulama yapma isteği Müdürlüğümüzce uygun görülmüş ve araştırmanın yapılacağı İlçe Milli Eğitim Müdürlüğüne bilgi verilmiştir.

Anketlerin uygulama yapılacak sayıda çoğaltılması ve çalışmanın bitimimde iki örneğinin (CD ortamında) Müdürlüğümüz Strateji Geliştirme Bölümüne gönderilmesini rica ederim.

İlhan KOÇ
Müdür a.
Şube Müdürü

Güvenli Elektronik ...
Aslı İle Aynıdır.
05.04./2013

Yaşar SUBAŞI

10-04-2013-6183

Bu belge, 5070 sayılı Elektronik İmza Kanununun 5 inci maddesi gereğince güvenli elektronik imza ile imzalanmıştır
Evrak teyidi http://evraksorgu.meb.gov.tr adresinden f6a3-6c1e-3944-a286-9ba3 kodu ile yapılabilir.

Emniyet Mh. Alparslan Türkeş Cd. No: 4/A Yenimahalle/ANKARA
www.ankara.meb.gov.tr
istatistik06@meb.gov.tr

Ayrıntılı bilgi için: Murat YILMAZER
Tel: (0 312) 212 36 00
Faks: (0 312) 212 02 16

APPENDIX T

CONSENT FORM

Bu çalışma, Arş. Grv. Beril Yılmaz Senem tarafından yürütülen bir çalışmadır. Çalışmanın amacı, 9. Sınıf fizik dersinde bilimsel süreç becerilerine ne kadar yer verildiğini ortaya çıkarmaktır. Çalışmaya katılım tamimiyle gönüllülük temelindedir. Gözlemde, sizden kimlik belirleyici hiçbir bilgi istenmemektedir. Yapılan gözlemler tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayımlarda kullanılacaktır.

Gözlem sırasında araştırmacının müdahalesi söz konusu olmadığından, genel olarak kişisel rahatsızlık verecek nitelikte değildir. Ancak, gözlem sırasında kayıt alınmasından ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz kayıt alma işini yarıda bırakmayı teklif edebilirsiniz. Gözlem sonunda, bu çalışmayla ilgili varsa tüm sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için ODTÜ Eğitim Fakültesi, OFMAE Bölümü araştırma görevlilerinden Arş. Grv. Beril Yılmaz Senem (Oda: EF204; Tel: 210 3686; E-posta: yberil@metu.edu.tr) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad	Tarih	İmza	Alınan Ders
	----/----/-----		

APPENDIX U

MATRIX FOR EACH CODE IN THE SPS

Observing

	OSTM	OSTMP	OSTP	OKD1	OKD2	OKD3	OKP1	OKP2	OKP3
1 : OSTM	5	0	0	0	0	0	1	0	0
2 : OSTMP	0	9	0	0	0	0	0	0	0
3 : OSTP	0	0	42	0	0	0	0	0	0
4 : OKD1	0	0	0	0	0	0	0	0	0
5 : OKD2	0	0	0	0	11	0	0	0	0
6 : OKD3	0	0	0	0	0	0	0	0	0
7 : OKP1	1	0	0	0	0	0	8	0	0
8 : OKP2	0	0	0	0	0	0	0	0	0
9 : OKP3	0	0	0	0	0	0	0	0	0

Measuring

	SSTM	SSTMP	SSTP	SKD1	SKD2	SKD3	SKD4	SKP1	SKP2	SKP3
1 : SSTM	21	0	0	0	0	0	0	0	1	0
2 : SSTMP	0	12	0	0	0	0	0	0	0	0
3 : SSTP	0	0	25	0	0	0	0	0	0	1
4 : SKD1	0	0	0	0	0	0	0	0	0	0
5 : SKD2	0	0	0	0	2	1	0	0	0	0
6 : SKD3	0	0	0	0	1	5	0	0	0	0
7 : SKD4	0	0	0	0	0	0	19	0	1	0
8 : SKP1	0	0	0	0	0	0	0	20	0	1
9 : SKP2	1	0	0	0	0	0	1	0	33	0
10 : SKP3	0	0	1	0	0	0	0	1	0	11

Inferring

	ISTM	ISTMP	ISTP	IKD1	IKD2	IKD3	IKP1	IKP2	IKP3
1 : ISTM	1	0	0	0	0	0	0	0	0
2 : ISTMP	0	36	0	0	0	0	0	0	0
3 : ISTP	0	0	27	0	0	0	0	0	0
4 : IKD1	0	0	0	0	0	0	0	0	0
5 : IKD2	0	0	0	0	1	0	0	0	0
6 : IKD3	0	0	0	0	0	0	0	0	0
7 : IKP1	0	0	0	0	0	0	0	0	0
8 : IKP2	0	0	0	0	0	0	0	0	0
9 : IKP3	0	0	0	0	0	0	0	0	0

Classifying

	LSTM1	LSTM2	LSRM	LKD1	LKD2	LKD3	LKD4	LKP1	LKP2	LKP3
1 : LSTM1	28	0	0	0	0	0	0	0	0	0
2 : LSTM2	0	9	0	0	0	0	1	0	0	0
3 : LSRM	0	0	0	0	0	0	0	0	0	0
4 : LKD1	0	0	0	0	0	0	0	0	0	0
5 : LKD2	0	0	0	0	0	0	0	0	0	0
6 : LKD3	0	0	0	0	0	0	0	0	0	0
7 : LKD4	0	1	0	0	0	0	42	0	0	0
8 : LKP1	0	0	0	0	0	0	0	0	0	0
9 : LKP2	0	0	0	0	0	0	0	0	0	0
10 : LKP3	0	0	0	0	0	0	0	0	0	0

Predicting

	PSTM1	PSTM2	PSTM3	PKD1	PKD2	PKD3	PKP1	PKP2	PKP3
1 : PSTM1	2	0	0	0	0	0	0	0	0
2 : PSTM2	0	36	0	0	0	0	0	0	0
3 : PSTM3	0	0	0	0	0	0	0	0	0
4 : PKD1	0	0	0	0	0	0	0	0	0
5 : PKD2	0	0	0	0	0	0	0	0	0
6 : PKD3	0	0	0	0	0	0	0	0	0
7 : PKP1	0	0	0	0	0	0	0	0	0
8 : PKP2	0	0	0	0	0	0	0	1	0
9 : PKP3	0	0	0	0	0	0	0	0	0

Communicating Scientifically

	CSTM	CSTMP	CSTP	CKD1	CKD2	CKD3	CKP1	CKP2	CKP3
1 : CSTM	0	0	0	0	0	0	0	0	0
2 : CSTMP	0	1	0	0	0	0	0	0	0
3 : CSTP	0	0	40	0	0	0	0	0	0
4 : CKD1	0	0	0	0	0	0	0	0	0
5 : CKD2	0	0	0	0	1	0	0	0	0
6 : CKD3	0	0	0	0	0	0	0	0	0
7 : CKP1	0	0	0	0	0	0	0	0	0
8 : CKP2	0	0	0	0	0	0	0	0	0
9 : CKP3	0	0	0	0	0	0	0	0	0

Hypothesizing

	HSTM1	HSTM2	HKD1	HKD2	HKD3	HKP1	HKP2	HKP3
1 : HSTM1	1	0	0	0	0	0	0	0
2 : HSTM2	0	3	0	0	0	0	0	0
3 : HKD1	0	0	0	0	0	0	0	0
4 : HKD2	0	0	0	6	0	0	0	0
5 : HKD3	0	0	0	0	0	0	0	0
6 : HKP1	0	0	0	0	0	2	0	0
7 : HKP2	0	0	0	0	0	0	0	0
8 : HKP3	0	0	0	0	0	0	0	0

Defining and Controlling Variables

	VSTM 1	VSTM 2	VSTM P	VSTP	VKD 1	VKD 2	VKD 3	VKP 1	VKP 2	VKP 3
1 :VSTM1	12	0	0	0	0	0	0	0	0	0
2 :VSTM2	0	0	0	0	0	0	0	0	0	0
3 :VSTMP	0	0	0	0	0	0	0	0	0	0
4 :VSTP	0	0	0	2	0	0	0	0	0	0
5 :VKD1	0	0	0	0	0	0	0	0	0	0
6 :VKD2	0	0	0	0	0	1	0	0	0	0
7 :VKD3	0	0	0	0	0	0	0	0	0	0
8 :VKP1	0	0	0	0	0	0	0	2	0	0
9 :VKP2	0	0	0	0	0	0	0	0	0	0
10 :VKP3	0	0	0	0	0	0	0	0	0	0

Experimenting

	ESTM	ESTMP	ESTP	EKD1	EKD2	EKD3	EKP1	EKP2	EKP3
1 : ESTM	0	0	0	0	0	0	0	0	0
2 : ESTMP	0	0	0	0	0	0	0	0	0
3 : ESTP	0	0	1	0	0	1	0	0	0
4 : EKD1	0	0	0	0	0	0	0	0	0
5 : EKD2	0	0	0	0	17	0	0	0	0
6 : EKD3	0	0	1	0	0	3	0	0	0
7 : EKP1	0	0	0	0	0	0	1	0	0
8 : EKP2	0	0	0	0	0	0	0	1	0
9 : EKP3	0	0	0	0	0	0	0	0	10

Collecting and Interpreting Data

	DSTM	DSTP	DSR1	DSR2	DKD1	DKD2	DKD3	DKP1	DKP2	DKP3
1 : DSTM	11	1	0	0	0	0	0	0	0	0
2 : DSTP	1	29	0	0	0	0	0	0	0	0
3 : DSR1	0	0	80	0	0	0	0	0	0	0
4 : DSR2	0	0	0	25	0	0	0	0	0	0
5 : DKD1	0	0	0	0	0	0	0	0	0	0
6 : DKD2	0	0	0	0	0	4	0	0	0	0
7 : DKD3	0	0	0	0	0	0	0	0	0	0
8 : DKP1	0	0	0	0	0	0	0	0	0	0
9 : DKP2	0	0	0	0	0	0	0	0	1	0
10 : DKP3	0	0	0	0	0	0	0	0	0	0

Modeling

	MSTM	MSTMP	MSTP	MKD1	MKD2	MKD3	MKD4	MKP1	MKP2	MKP3
1: MSTM	44	0	0	0	0	0	0	0	0	0
2:MSTMP	0	3	0	0	0	0	0	0	0	0
3: MSTP	0	0	3	0	0	0	0	0	0	0
4: MKD1	0	0	0	0	0	0	0	0	0	0
5: MKD2	0	0	0	0	5	1	0	0	0	0
6: MKD3	0	0	0	0	1	3	0	0	0	0
7: MKD4	0	0	0	0	0	0	23	0	0	0
8: MKP1	0	0	0	0	0	0	0	0	0	0
9: MKP2	0	0	0	0	0	0	0	0	0	0
10:MKP3	0	0	0	0	0	0	0	0	0	1

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Yılmaz Senem, Beril
Nationality: Turkish (TC)
Date and Place of Birth: 1 January 1982, Ankara
Marital Status: Married
Phone: +90 533 439 72 09
email: berilyilmaz@gmail.com

EDUCATION

Degree	**Institution**	**Year of Graduation**
BS & MS	METU Physics Education	2004
High School	Alp Private School	1999

WORK EXPERIENCE

Year	**Place**	**Enrollment**
2005-Present	METU, Dept. of Sec. Sci. & Math. Ed.	Research Assistant
2010-2011	University of Amsterdam, Amstel Inst.	Visitor Scholar

FOREIGN LANGUAGES

Advanced English, Elementary German

CONFERENCES

National

Yılmaz, B., Eryılmaz A. An Investigation of the Relationship between Students' Learning Styles and Their Preferences of Instructional and Assessment Methods. (Poster, was awarded as a First Prized Poster). VII. National Science and Mathematics Education Conference, 7-9 September, 2006, Ankara, Turkey.

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SYMPOSIUM

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Sen. H.C., Yılmaz Senem, B., & Pabuccu, A. The relationship between teacher and students according to new elementary school science curriculum. 17 November, 2007, Tevfik Fikret Schools Constructivism Symposium. Ankara.

HOBBIES

Member of METU Communication Club (Voluntary teaching), member of METU orienteering Team, Music, Dance, Folklore, Sociology.