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# Examining the Learning Outcomes Included in the Turkish Science Curriculum in Terms of Science Process Skills: A Document Analysis with Standards-Based Assessment

Umit Duruk[a], Abuzer Akgün[a], Ceylan Doğan[b], Fatma Gülsuyu[c]

[a]Adıyaman University, Adıyaman, TURKEY;
[b]Ministry of National Education, Adıyaman, TURKEY;
[c]Masters Student, Adıyaman, TURKEY.

ABSTRACT

Science process skills have provided a valuable chance for everyone to construct their own knowledge by means of scientific inquiry. If students are to understand what science is and how it actually works, then they should necessarily make use of their science process skills as well as scientific content knowledge compulsory to be learned in any science curriculums. As an important schooling item, science curriculums based on scientific literacy have been reoriented at times and aimed at providing students with a deeper understanding of science process skills and make them fully competent to deal with scientific process as far as possible. The present study took its inspiration for examining the role of science curriculum on science process skills from the purpose of investigating learning outcomes in it. The study was conducted in accordance with document analysis of Turkish Secondary School Science Curriculum revised in 2013. The analysis was operated by standards-based assessment of learning outcomes with the help of sentence-based criteria constructed by researchers. The results showed that the representation rate of science process skills for science curriculum varied with grade level and unit. Based on the results, the implications and limitations of the study and the directions for further study were discussed.

KEYWORDS
Science education, science process skills, science curriculum, document analysis

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## Introduction

Science is basically an observational process based on some of the statements under the possibility of being falsified by criticism. That is, contrary to common myth, it should not be seen as a pile of inert knowledge possessing absolute facts. Moreover, scientific knowledge itself has a constructivist nature considering the basic assumption that any knowledge collected by scientific methods is even subject to change (Yıldırım, 2007). It is therefore so important to provide students with informed views about science and its methods to collect scientific data and develop their understanding of science by this way. Improving students'

CORRESPONDENCE Umit Duruk yumitt41@hotmail.com

understanding of science could be recognized as an implicit and in many cases explicit investment for a public in an attempt to raise overall understanding of science. However, further effort is needed for nations to provide their citizens with a variety of skills in order to participate fully in the knowledge-driven society even in the long run. The key issue of concern is how nations should educate their citizens with their sources allocated in the educational settings. The contemporary education mainly aims to provide students with the ways of getting information rather than transferring this information without using any of those ways. In a sense, the rapid shift in the science and technology necessitates a society with qualified citizens capable of being a producer of knowledge, an explorer of the ways of knowing and a problem solver with different point of view to certain complex circumstances.

One of the basic goals of science education is the fulfilment of the thought that students should have sufficient ability to do science (NRC, 1996; Martin, 1997; Taconis, Ferguson-Hessler & Broekkamp, 2000). Doing science, on the other hand, requires students obtain more complicated skills rather than learning science (Rezba, Sprague, McDonnough & Matkins, 2007; Hazır & Türkmen, 2008; Osborne & Patterson, 2012). To comprehend science and its processes deeply, students need to facilitate their capacities and exploit it with the help of their daily experiences (Akgün, Tokur & Duruk, 2016). It is important to acknowledge that students possessing a wide range of inaccurate knowledge settled by formal science instruction or by informal learning need to be provided some basic requirements to inquire about the scientific phenomena and make reasonable decisions through experimenting and reaching related conclusions. Students keen on interpreting and producing new knowledge are expected to be active learners and seek to perform by doing science on meaningful learning in their daily lives rely heavily on real life situations (Bagcı Kılıc, 2003; Monhardt & Monhardt, 2006). Active learning process is constructed on the basis of the inquiry learning that advocates inquiry-based active learning as something students actually do in terms of science, not those they are exposed to learn (Harlen, 1999). This inquiry process is considered as having significant and fruitful relationship to scientific inquiry (Anderson, 2002; Settlage & Southerland, 2007). Inquiry learning attributes much of its reputation to constructivist learning paradigm which supports the view that constructing process of any given knowledge is brought about in the mind of the learners accompanied by their own experiences (Zion, Michalsky & Mevarech, 2005). In addition to this view, Lederman, Lederman, Bartos, Bartels, Meyer & Schwartz (2014) point out that scientific inquiry makes science process skills and other bodies of knowledge or thinking abilities come together in order to develop new scientific knowledge. Science teaching is based on inquiry-based learning in the course of teaching a blend of science content knowledge and science process skills (NRC, 2007; MoNE, 2013). As already mentioned, scientific inquiry relates to certain procedures needed for producing new knowledge and, without using science process skills, students get into trouble in everyday life (Rillero, 1998; Aydogdu, Erkol & Erten, 2014). With a broader perspective, scientific inquiry includes diverse ways in which the natural world is under investigation with their prospective descriptions or explanations stem from scientific entrepreneurship. Besides, it is heavily based on the scientific process skills used in the field of science education and its importance persists on making students more competitive in the changing world (Nehring, Nowak, zu Belzen, & Tiemann, 2015).

Learning is a never ending process itself. Research on the learning process focuses on the issue of how learning occurs and how individuals learn. As some veteran researchers such as Piaget and Vygotsky with their cognitive and social views advocate mainly the constructivist ways of learning in which individuals construct their own learning by themselves integrating new knowledge received with those they already had. Here, the present study does not have any implications or interpretations on how individuals construct their knowledge in terms of cognitive and social meanings. The main purpose here is to reveal the relationships between constructivist learning approach and schooling implications. One of the well-known schooling items are teaching programmes. Teaching programmes are required to have the potential and disclose it to breed scientifically literate citizens (AAAS, 1989; NRC, 1996; Laugksch, 2000; DeBoer, 2000; MoNE, 2006, 2013). Many educational reforms and teaching curriculums have taken such initiatives putting up with a notion that scientific literacy is needed for the teaching programmes as an innovative vision of educational efforts worldwide. Taking into consideration, MoNE have made some radical decisions on the teaching programmes including science programmes. Under the vision of scientific literacy, science curriculum ascribed a pivotal role on alternative learning strategies and scientific inquiry learning as a student-centred approach has come into prominence by terms of science education and its implications in various educational settings.

As an important schooling item, teaching programmes are formed as a steady response to the establishment of knowledge-based society by constructing an enduring ground having complicated relationships between people and society in which they live. People are therefore made compelled to use some of the skills in order to survive, in part, in a technology-driven agenda. Given the importance of the relationship between academic goal orientations, scientific skills have not been empirically addressed more often in the literature. As echoed in the related literature, science process skills have been identified by lots of theoretical frameworks that contain various reasonable types of point of view to construct a base line to depict a whole picture of scientific skills.

## Science Process Skills

Ensuring that students improve their skills for research, investigation and critical thinking and become life-long learners is a priority among the purposes of science teaching. Accordingly, science process skills (SPS, henceforth) are extremely important in the process of training students who have these traits. SPS is considered as decisive and inseparable part of science education (Farsakoglu, Sahin & Karslı, 2012; Akgün & Duruk, 2016). Mainly, SPS is thinking skills that scientists use to construct knowledge in order to solve and evaluate problems as well as formulate results (Ostlund, 1992; Ozgelen, 2012). In the same vein, NRC (2000) recommends the usage of learning based on research and investigation in order to improve SPS. In addition, students' utilisation of these skills they use to structure scientific information, not only allows them to process new information through tangible experiences, but also helps them understand the nature of science (Abd-El-Khalick, Bell, & Lederman, 1998). SPS is mainly addressed in two groups as BSPS and ISPS. BSPS are observation, classifying, measuring, using numbers, establishing space/time relations, predicting, inferring and communication. ISPS are defining and controlling variables, formulating and testing hypotheses, operational definition, experimentation and data interpretation (Shaw, 1983; Rezba et al., 2007; Kanlı & Yagbasan, 2008; Chabalengula, Mumba & Mbewe, 2012; Ozgelen, 2012; Aslan, Ertas-Kılıc & Kılıc, 2016). It may be argued that BSPS refer more to the empirical characteristic of science, while experiment confirmation SPS, and genuine experiment design and implementation SPS is focused more on the analytical characteristic of science. Individuals with developed SPS may have a more persistent, more meaningful knowledge base that is far from false conceptualisations, as they take part actively in the process of obtaining information and they structure their information by themselves under supervision of their teachers (Sen & Nakiboğlu, 2012). In addition to physical skills used in research and investigation processes, ISPS also includes significant cognitive skills (Aslan, Ertas-Kılıc & Kılıc, 2016). Consequently, it has been frequently stated that BSPS is prerequisite for development of ISPS (Padilla, 1990; Martin, 1997; Ewers, 2001; Bagcı Kılıc, Haymana & Bozyılmaz, 2008; Al-Rabaani, 2014).

## Basic Science Process Skills (BSPS)

### *Observation*

Observation is the most wide-spread and fundamental application of science. As a fundamental way of gathering information with senses about phenomena in an analytical perspective, observation refers to the result of observing turning into data or fact in the end. This skill is seen as the first and most important step of SPS and sets a basis for other skills. Skilled observers seem to proceed from general perceptions of a system to more specific ones. Observation may be addressed in two dimensions as qualitative and quantitative. A substance’s qualitative properties such as its colour, shape and smell are observed in qualitative observation. Quantitative observation, on the other hand, is concerned with quantities such as number or amount (Arthur, 1993; Aslan, Ertas-Kılıc & Kılıc, 2016).

### *Classifying*

Classifying is an organisation of observable traits belonging to objects or facts in accordance with the relationship between them. It is an important process since it acknowledges the basic assumption that any similarity in one regard may also encompass the similarity in others. Moreover, classifying of existing or newly-explored objects or facts into different categories prevent them from getting abstruse or entirely lost. Therefore, classifying has an exclusive role on the construction of a vast array of conceptions. This is because facts and generalisations must be gathered and organised for concept establishment. Classifying is utilised in this organisation (Ostlund, 1992; Karahan, 2006).

### *Communication*

Communication includes the process of sharing information, emotions, thoughts and experiences in certain ways. One of the most important characteristics of communication is that it aims to reach an agreement on a common understanding. Students have to communicate in order to share their observations with someone else. It is important that scientific language is used in facilitation of this communication. Students need to learn the corresponding meanings of the objects or events they are analysing in the scientific language and transfer them into their daily lives (Aslan, Ertas-Kılıc & Kılıc, 2016).

### *Measuring*

Expression of a quality in terms of numbers or symbols after observation is called measuring. Quantitative expression of characteristics belonging to objects or events after measurement increases the quality and certainty of the results. The data obtained as a result of measurement makes technical communication easier by ensuring that everyone understands the same thing from the results (Arthur, 1993; Aslan, Ertas-Kılıc & Kılıc, 2016).

### *Predicting*

Predicting is establishing ideas towards possible events in the future and their outcomes based on previous experiences, and evidence and data obtained as a result of observation. In order to make a reliable prediction, observations must be careful and relationships among observed events must be interpreted correctly. While inferences are possible explanations for past events, predictions are related to situations that are likely to occur in the future (Aslan, Ertas-Kılıc & Kılıc, 2016).

### *Inferring*

Inferences are possible explanations for past events. Observations and inferences are different things. Scientists rely on evidence while inferring upon events they have not observed. Inferring may be defined as reaching a logical conclusion using observations, or reaching conclusions based on evidence where making observations is impossible (Aslan, Ertas-Kılıc & Kılıc, 2016).

## Integrated Science Process Skills (ISPS)

### *Interpreting data*

Interpreting data has been recognised to be connected with analysing data in such a way that one can easily locate any patterns leading to inferences or hypotheses. In other words, interpreting data refers to making conclusions by means of observations used to collect empirical data systematically. This data could be both quantitative and qualitative, as well. Interpreting qualitative data is more subjective in nature than that of quantitative data. Consequently, the process of interpreting data is prone to be influenced by any slight changes depend on the kind of the data. As data producers, students should use tables and graphs to analyse and synthesize data so as to construct their inferences and investigate it in an organized way (Padilla, 1990; Arthur, 1993; Yıldırım & Simsek, 2013).

### *Controlling variables*

Qualities and quantities that change from situation to situation are called variables. All possible factors that may affect the result of an experiment are established by determining the variables. Variables are generally categorised as independent, dependent and control variables. Correctly revealing the relationships among these three variables will increase the validity and reliability of the data obtained as a result of the experiment. Students need practice in identifying variables that affect outcomes (Celik, 2013).

## Experimenting

Inquiry-based learning calls for students use higher-order thinking skills to draw evidence-based conclusions. In this process, they need to utilize a variety of SPS such as collecting data, identifying variables, and formulating hypothesis, so on. Concurrently, it could be generalized that experimenting includes most of the SPS and put them together for in-depth analysis while conducting repeated trials. Student should evince readiness to understand the application of scientific method though inquiry for self-design experiments to formulate and test a hypothesis (Aslan, Ertas-Kılıc & Kılıc, 2016).

## Formulating hypothesis

Hypothesis is a proposal based on an educated guess stems from prior knowledge and repeated observations. It could also be described as an inferred explanation of an observation. A scientific hypothesis needs several requirements if it is to explain observable phenomena. It should be both testable and falsifiable (Ostlund, 1992).

## Defining operationally

Similar to formulating hypothesis, operationally defining is carried out with regard to data collected by prior knowledge and observations. After putting forward the hypothesis, the first thing to do is to operationally define how the variables observed in the process are measured. The main advantage of defining operationally could be seen as there are a lot of ways of measuring related phenomena. The key point of the operationally defining is the fact that it is used only for the phenomena and related variables that cannot be measured directly (Aslan, Ertas-Kılıc & Kılıc, 2016).

## Modelling

Models refer to constructing a mental, verbal or physical model of ideas or objects within a process or event. They are formulated to clarify more accurate explanations and disclose possible relationships (Padilla, 1990).

## Prior research related to SPS

Research on SPS is vast in the related literature since it has solid basis combining several well-known conceptions or approaches in science education such as science, scientific processes, inquiry-based learning and active learning. Previous research studies could be categorized in four related but fundamentally distinct lines given as follows in Table 1.

The studies in the literature were reviewed in this section under four distinct lines. When these studies were reviewed in terms of problem fields, it may be seen that some of them have investigated the SPS of teachers and prospective teachers, while some others have investigated SPS of students. These are mainly descriptive studies which aim to reveal opinions of teachers and prospective teachers on their SPS. Additionally, there exist studies that aim to improve SPS of preservice teachers. In addition to the first two lines, the third and fourth lines include studies that investigate SPS in terms of their representation in textbooks and science curriculum, respectively. Consequently, the studies marked with '*' were reviewed under both lines.

**Table 1.** Studies categorized in four related as well as distinct lines

| **Studies on teachers' SPS** | **Studies on students' SPS** |
|---|---|
| Kanlı & Yagbasan (2008) | Berman (1996) |
| Karslı, Sahin & Ayas (2009) | Beaumont-Walters & Soyibo (2001) |
| Sinan & Usak (2011) | Ewers (2001) |
| Chabalengula, Mumba & Mbewe (2012) | Saat (2004) |
| Farsakoglu, Sahin & Karslı (2012) | Aydınlı (2007) |
| Ambross, Meiring & Blignaut (2014) | Ozturk, Tezel & Acat (2010) |
| Aydogdu, Erkol & Erten (2014) | Böyük, Tanık & Saracoglu (2011) |
| Molefe & Stears (2014) | Delen & Kesercioglu (2012) |
| Aydogdu (2015) | Nehring, Nowak, zu Belzen & Tiemann (2015) |
| | Güden & Timur (2016) |
| **Studies analysing SPS included in textbooks** | **Studies analysing SPS included in science curricula** |
| Lumbantobing (2004)* | Lumbantobing (2004)* |
| Dökme (2005) | Koray, Bahadır & Gecgin (2006)* |
| Koray, Bahadır & Gecgin (2006)* | Kılıc, Haymana & Bozyılmaz (2008) |
| Aziz & Zain (2010) | Yılmaz Senem (2013)* |
| Lacin-Simsek (2010) | Saban, Aydogdu & Elmas (2014) |
| Ağgül Yalçın (2011) | |
| Sen & Nakiboglu (2012) | |
| Yıldız, Feyzioglu & Tatar (2012) | |
| Yılmaz Senem (2013)* | |
| Aslan (2015) | |

**These studies took part in both groups.*

## Studies on teachers' SPS

Some studies have asserted that both science teachers and preservice science teachers have been lacking accurate understandings of SPS (Aydogdu, 2006; Karslı, Sahin & Ayas, 2009). In their case study, Karslı, Şahin & Ayas (2009) investigated ten science teachers' views about SPS. Analysis of categorized qualitative data indicated that most of the science teachers lacked theoretical knowledge about SPS. In another study, Sinan & Usak (2011) observed preservice science teachers' SPS using an observation form. The results indicated that preservice biology teachers are quite competent in biochemisty course in terms of SPS. Chabalengula et al. (2012) carried out a study investigating preservice teachers' conceptual understanding as well as their performances regarding SPS. They were exposed to both introductory and advanced science methods course. In conclusion, the study indicated that preservice teachers performed better SPS despite they have insufficient conceptual understanding and they are unable to describe SPS accurately. Given the results with these three studies, it could be inferred that there is a difference between the views or understandings and practical implications of SPS. Farsakoglu, Sahin & Karslı (2012) conducted a cross-sectional research with undergraduate students in order to find out if there is a linear progress in their SPS. This analysis was operated with regard to SPS including "identifying variables and formulating hypothesis", "experimenting and controlling variables", "collecting data", "drawing graphs" and "interpreting data". As a result, they found out that there is no linear progress in terms of SPS. Ambross, Meiring & Blignaut (2014) conducted a multiple case study with natural sciences teachers. They based their study on a previous framework that separates "understanding" into two categories as conceptual understanding and procedural understanding. With this regard, researchers analysed some of qualitative data collected by focus group discussions and they concluded that SPS are influenced by teachers' understandings of SPS. The study conducted by Aydogdu et al. (2014) investigated elementary school teachers' SPS according to some variables. In addition to other results, it was concluded that elementary school teachers' ISPS are not enough. In another study with interpretive approach, Molefe & Stears (2014) analysed science teacher educators' beliefs expected to have an effect on teaching SPS. The results showed that science teacher educators have different views on the importance of those skills and mention about both some core skills and generic skills. Finally, Aydogdu (2015) attempted to investigate SPS and found out that science teachers' ISPS were not sufficient. Beside, ISPS were found to be related to the frequency of using those skills in the classroom.

## Studies on students' SPS

There are also studies investigating students' SPS. Among other most striking studies, Beaumont-Walters & Soyibo (2001) investigated high school students' ISPS and found it low. For instance, interpreting data was found much more than formulating hypothesis and identifying variables. In addition, it was pointed out there was a weak relationship between SPS and grade level despite there exist several research studies advocating a significant relationship between two of them. In another study focused on ISPS, Saat (2004) operated a qualitative case study analysing specifically the acquisition process of controlling variables through web-based learning approach. In the end, it was suggested that the skill of controlling variables accounts for three phases as recognition, familiarization and automation, respectively. Some studies revealed that there is a positive relationship between SPS and academic success in science courses (Beaumont-Walters & Soyibo, 2001; Farsakoglu, Sahin & Karslı, 2012). Aydogdu (2006) found SPS of second grade students of elementary education weak. Similarly, Beaumont-Walters & Soyibo (2001) found SPS of high schools students low and inadequate. Aydınlı (2007), Oztürk, Tezel & Acat (2010) and Böyük et al. (2011) found significant differences of secondary school students in terms of several demographic variables. Böyük et al. (2011) also figure it out that secondary school students are more competent in BSPS compared to ISPS. They were found to be good at classifying in spite of being insufficient regarding experimenting and controlling variables. Delen & Kesercioglu (2012) analysed both secondary school students' SPS and its possible relationship with academic achievement. In their study, students from sixth and seventh grade were evaluated by new science curriculum; in contrast eighth grade students were evaluated by the previous science curriculum. They concluded that the students are below average in terms of SPS and there is a positive relationship between SPS and academic achievement. In addition, eighth grade students scored best in BSPS such as observing and classifying.

## Studies analyzing SPS included in the textbooks

Koray et al. (2006) analysed ninth grade chemistry curriculum and chemistry textbooks together. The study revealed that the representation rate of SPS is inconsistent with each other. Despite SPS such as data recording, interpreting and experimenting represented sufficiently in the chemistry textbooks, chemistry curriculum does not contain these skills quite enough. Results also indicated that chemistry textbooks were prepared to develop students' experimenting skills. However, chemistry curriculum skipped this skill. Ağgül Yalcın (2011) aimed at evaluating the eighth grade science teacher guide book on the basis of SPS. Researcher used a 10-item rubric to evaluate SPS more accurately as required by standard-based evaluating. After analysis, it was concluded that science teacher guide books are prepared at a satisfactory level needed for facilitating SPS. Another result reached in the study, science teacher guide books do not represent the skill of controlling variables sufficiently. The highest rate of representation, on the other hand, belongs to the skills of communication and inferring. In her descriptive qualitative study, Lacin Simsek (2010) investigated the adequacy of teacher candidates about the purposes of experiments and SPS take part in the fourth and fifth grade science textbooks. She found that teacher candidates were able to determine the purposes of the experiments. However, they had difficulty in determining some of the skills including controlling variables, making hypothesis and modelling. Aslan (2015) operated a comprehensive content analysis of science activities in science textbooks prepared for secondary school students. Science activities were found at starting level and controlling variables is not reflected fully in the science textbooks. Lastly, the representation rate of SPS differs from each grade and unit. Lumbantobing (2004) analysed science textbooks including hands-on activities prevailing in Indonesia and Japan. The study put forward that there is more emphasis on BSPS. Similarly, Aziz & Zain (2010) conducted a comparative study investigating SPS included in the physics textbooks in Yemeni schools. The results indicated that eleventh grade physics textbooks lack of measuring, predicting and hypothesizing. Besides, there is inconsistency with physics textbooks with regard to the distribution of SPS. In another study, Yıldız Feyzioglu & Tatar (2012) carried out an intensive work trying to examine secondary school science textbooks in terms of SPS. As most of the studies mentioned, this study confirms that SPS do not exist in some textbooks or represented at different levels. The lowest rate of representation belongs to the skill of hypothesizing.

## Studies analyzing SPS included in the science curriculum

This line has been the core part of the present study. Therefore, the studies in this line were undergone a more detailed review. In their one of the pioneering qualitative study, Bagcı Kılıc et al. (2008) focused on the investigation of 2005 Science Curriculum in terms of scientific literacy and SPS. Researchers analysed both learning outcomes and proposed activities in the science curriculum and made an assessment according to the codes they reached in the course of longitudinal analysis over weeks. Excluding the results regarding scientific literacy, the study concluded that BSPS are more represented than ISPS. The most attributed basic skills were observing, comparing and inferring. The skills of classifying and predicting as well as measuring and communication are among the least emphasized ones as BSPS. It was also supported that SPS in the activities are also more represented than ISPS. In conclusion, ISPS are neglected at all grade levels.

Yılmaz Senem (2013), in her comprehensive thesis with various data collection tools, investigated ninth grade physics curriculum and physics textbook to what extent they represent SPS and how consistent with each other these documents are. Additionally, the researcher analysed the classroom with observation records of three physics teachers as a data collection tool. As a result of the research, it was found that ninth grade physics curriculum was adequate in terms of data collection and interpretation skills, while it was inadequate in terms of predicting, experimenting and inferring. Similarly, ninth grade physics textbook was found to be sufficient in terms of data collection and interpretation, and measuring skills, while being found inadequate in terms skills of formulating hypotheses and controlling variables. Given the results of observations in classes, it was seen that modelling skill was frequently included in classes, but models did not surpass the level of mathematical equations. It was also observed that the skill of measuring that was adequately represented in the textbook was operated problematically during classes.

In their comparative study, Saban et al. (2014) examined 2005 Science Curriculum and 2013 Science Curriculum in terms of SPS at fourth and fifth grade level. Both curriculums were analysed by content analysis with regard to the aspects including basic principles, content, aims, teaching process and evaluation. Each learning outcome was considered as an analysis unit during the analysis of the aims in the curriculums whereas each sentence was used in the analysis of other aspects. In conclusion, it was found out that there is more emphasis on SPS in 2013 Science Curriculum unlike 2005 Science Curriculum regarding the aspect of basic principles. In addition, SPS were represented at the rate of 25% (3 out of 12) in the aims of 2013 Science Curriculum. However, 2005 Science Curriculum is more comprehensive since it contains SPS by categorizing them and each unit has its own master SPS. 2013 Science Curriculum, on the other hand, is limited compared to its counterpart. This deficiency held on to consider which SPS are aimed to gain at different grades. Therefore, researchers concluded that, in terms of SPS, 2005 Science Curriculum is more detailed than the next one. Ultimately, considering 2005 Science Curriculum is more detailed, researchers pointed out that the presentation of the learning outcomes at the cognitive level belong to SPS with the master activities provide teachers guidance. Consequently, the science curriculum increased its effectiveness and achievement.

## Study rationale

Science curriculum has a crucial role on the organization of textbooks, lesson plans, activities and auxiliary resources. Teachers facilitate science curriculums to construct and reorganize their lesson plans (Phillips, Vowell, Lee, & Plankis, 2015). Hence, schooling items, especially science curriculums, are of vital importance on both knowledge and skills to integrate them into science lessons. Among other proficiencies, SPS are seen as important goals in recent years, especially in science education (Yılmaz Senem, 2013). Moreover, science curriculum revised in the year of 2013 focuses on the learning approach based on investigation. SPS also include scientific reasoning skills that a scientifically literate individual must have (Anderson, 2002). Students' utilisation of high-level skills such as research, investigation, analysis and interpretation is based on how effectively they use their SPS (Aslan, 2015). As a significant reduction of the learning outcomes were resorted to in comparison to 2005 science curriculum, and 2013 science curriculum refers more to inquiry-based learning in comparison to the previous one, development of scientific reasoning skills has gained more importance.

It is a well-established issue among researchers why a study is of importance to be done. There is a common perception that new research should have a generative nature boosting the existing literature with its capacity to resolve controversies, advance the understanding and fill the gaps which could be beneficial or useful to reach more meaningful results likely to be taken into consideration. Accordingly, the present study is thought to help getting more advanced and more informed understandings of SPS with a perspective that analysing merely learning outcomes whereas most of the other studies do it with the analysis of science textbooks and science activities related to the units. In addition, the studies have consistently advocated that BSPS have more emphasis in comparison to ISPS and students and even teachers are lacking these skills, especially in terms of ISPS. Beside, SPS are varied according to grade and unit in the science curriculum. Lastly, it has been put into forward that SPS are embedded in the learning outcomes of 2013 science curriculum. Therefore, it is implicitly stated that they are represented indirectly (Saban et al., 2014). Considering all arguments mentioned here previously, the study is expected to broad the current knowledge in the literature with suggestions and future implications given at the end of the study.

## Purpose of the study

The purpose of the present study is to investigate the current position of science curriculum in terms of SPS whether their representation in the curriculum varies according to grade and unit. To categorize these skills, some of the studies existing in the literature were specifically reviewed (Padilla, 1990) and their conceptual framework was adopted as the main framework of the present study. The study reports on scientific process skills in relation to twelve nominated skills chosen after a broad literature review. The study was guided by the following three research questions that correspond to the purpose of the study:

1. To what extent are SPS represented in the Turkish $5^{th}$, $6^{th}$, $7^{th}$ and $8^{th}$ Grade Science Curriculum?
2. To what extent are SPS represented in the units of the Turkish $5^{th}$, $6^{th}$, $7^{th}$ and $8^{th}$ Grade Science Curriculum?
3. To what extent are SPS represented in the Turkish $5^{th}$, $6^{th}$, $7^{th}$ and $8^{th}$ Grade Science Curriculum in terms of BSPS and ISPS?

## Methodology

This study was conducted in the framework of a qualitative research approach. The data addressed in the study were analysed in compliance with the understanding of qualitative research by the method of document analysis. The outcomes belonging to the version of the scientific education curriculum updated in 2013 were investigated by consideration of the units they belonged to. Table 2 shows the criteria used in analysing process of SPS in terms of BSPS and ISPS; Table 3 shows the distributions as percentages of these skills in terms of grades, and Table 4 shows the distributions as percentages of these skills in terms of units.

## Model

The present study utilized a descriptive analysis using data collected through the analysis of science curriculum. Firstly, a theoretical framework put forward by Padilla (1990) was selected as the main leading framework to operate the present study. All four researchers analysed all the learning outcomes belong to all units included in the science curriculum from 5th grade to 8th grade. These learning outcomes were categorized under the titles of BSPS and ISPS. The present study included observation, classifying, communication, measuring, predicting and inferring as BSPS and interpreting data, controlling variables, experimenting, formulating hypotheses, defining operationally and formulating models as ISPS, respectively.

## Data collection and instruments

2013 Science Curriculum is a revised form of the previous curriculum that has been implemented since 2005. The latter curriculum is a baseline for the present curriculum. Similarly, 2013 science curriculum also stands for the term of scientific literacy and aims to breed scientifically literate citizens. However, the present curriculum has comparatively fewer learning outcomes and does not have any science activities guide teachers in the course of teaching science. It has four learning areas as knowledge, skill, affection and science-technology-society-environment. The first learning area is "knowledge" and is comprised of four cognitive strands as "living things and life", "matter and change", "physical facts" and "earth and universe". The other learning area is related to "skill". This learning area is divided into two strands as "SPS" and "Life Skills". Life skills also contain analytical thinking, decision-making, creative thinking, entrepreneurship, communication and team-working, respectively. The third learning area is about affective features. This category includes attitudes, motivation, values and responsibility. The last learning area in the curriculum comprises of socio-scientific issues, nature of science, the relationship between science and technology, the social contribution of science, consciousness of sustainable development and career in scientific endeavour.

The only data source in the present study is 2013 science curriculum. This data source was retrieved from the web site of Head Council of Education and Morality (Talim ve Terbiye Kurulu Başkanlığı). Data were analysed by using document analysis to view the distribution of SPS into units and their percentages are given in tables according to their evaluation criteria. Instrument to evaluate the science curriculum was developed by the researchers after reviews and discussions mutually.

## Data Analysis

Data analysis was conducted through document analysis to address the research questions stated in the present study. The analysis procedure was mainly twofold. The first one was related to the construction of a sentence-based criterion to categorize the learning outcomes in the science curriculum, and the other one was related to the accurate categorization of those learning outcomes according to grade level and unit. Before the analysis, all researchers sought to determine and utilize a common assessment criterion to eliminate possible errors or bias in the course of categorizing the learning outcomes into basic and integrated SPS. However, it is also important to be noted that, commonly in qualitative studies, an individual analysis to categorize any data needs to be supported by a sense of the group interaction constructed by the help of other experienced coders. That is to say, coders' individual interpretations depend on the context. In other words, it is prone to be altered through time and space (Åkerlind, 2005). To alleviate this effect, all four researchers agreed upon for carrying out open coding as a qualitative coding technique and they read all the learning outcomes individually (Charmaz, 2006). After individual reviews, researchers discussed about the learning outcomes and tried to reconcile mutually on a piles of sentence-based criteria. Subsequently, coder reliability check was examined (Kvale, 1996). It was found that the learning outcomes matched with SPS at a satisfying rate above 85% (Miles & Huberman, 1994). Disagreements were overcome by discussing to ensure dialogic reliability check (Åkerlind, 2005). Sentence-based criteria list is given in Table 2:

As a result, a learning outcome having an ending such as "explores........", "investigates..........", "observes........." was included into the category of "*observation*". As given in the example, the category of "*classifying*" refers to "compares.......", and "classifies..........". The other category "*communication*" is related to "presents........" and "discusses............". The category of "*measuring*" refers to "computing......." and "measures......". The last two categories "*predicting*" and "*inferring*" refers to the endings such as "predicts......" and "infers......", respectively.

**Table 2.** Sentence-based criteria to assess the learning outcomes in the science curriculum

| Basic Science Process Skills (BSPS) | |
|---|---|
| Observation | "explores.......", "investigates..........", "observes........." |
| Classifying | "compares.......", and "classifies..........". |
| Communication | "presents......." and "discusses............". |
| Measuring | "computing......." and "measures......". |
| Predicting | "predicts......" |
| Inferring | "infers......" |
| **Integrated Science Process Skills (ISPS)** | |
| Interpreting data | "associates......." |
| Controlling variables | "tests variables", "analyses relations" |
| Experimenting | "tests........", "makes experiments on...." "explores through experiments" |
| Formulating hypothesis | "formulates a hypothesis about...." |
| Defining operationally | "defines it operationally as...." |
| Modelling | "designs......." |

The learning outcomes are also coded into ISPS with the help of the same criteria. For instance, a learning outcome with an ending "associates..." refers to interpreting data, "tests variables..." and "analyses relations..." refer to controlling variables, "tests.....", "makes experiments on...", and "explores through experiments..." refer to experimenting, "formulates a hypothesis about..." refers to formulating hypothesis, "defines it operationally as..." refers to defining operationally and finally a learning outcome with an ending "designs..." refers to the skill of modelling.

After the determination of sentence-based criteria abovementioned, it should also be considered that any study needs to be valid and reliable to prove itself having the requirements for a scientific research. In other words, data in the study with high reliability coefficients means that the study is more trustworthy. In the present study, the analysis process of the learning outcomes contains intercoder agreement among the four coders for the categorization of those into SPS by means of the standards-based instrument (Table 2) developed by researchers. More specifically, this analysis process began with the categorization of all the learning outcomes in the science curriculum into twelve SPS by all researchers individually as mentioned before. To meet the second fold of the analysis procedure, the researchers assigned the learning outcomes to SPS by calculating their accumulated sum located in the tables according to grade level (Table 3) and unit (Table 4). If the learning outcomes were related to more than one category of SPS, related learning outcome was coded into more than one category. For instance, a learning outcome might be related to observation, communication and experimenting at the same time. To ensure the reliability of the analysis conducted with regard to coding the learning outcomes into SPS, codes from the researchers in the study were compared and the reliability of agreement coefficient for this analysis was found to be 85.33 (Miles & Huberman, 1994).

The reliability analysis given above, as it only contains percentage values, ignores the possibility that the conformity among coders might be due to coincidence. Therefore, as the data of the study were coded by a constant number of coders (4) higher than two, Fleiss' kappa was also considered in addition to the analysis of agreement percentage in form of simple percentage ratios. It was seen that the value of Fleiss' kappa, which provides more reliable results by addressing the probability that agreement among coders is due to chance, and is suitable for analysis with more than two coders, showed moderate agreement. Therefore, considering the agreement coefficient and the kappa coefficient, the analysis by the researchers was found to be reliable.

## Findings

In this section, viewing Table 3, SPS were investigated separately in terms of school years (grades). In the analysis based on grades, among SPS in the fifth grade science curriculum, it was seen that the most represented skill was communication (27.27%), while measuring is the least (2.27%). Observation had a significant representation rate (20.45%). This situation is substantial because observation is the most important one among BSPS and it sets a basis for others. When ISPS were considered, the learning outcomes mainly focused on experimenting (22.72%). Surprisingly, skills for formulating hypotheses and operational definition were not represented at all.

Observation and classifying skills were on top ranks when BSPS in the sixth grade science curriculum were investigated (21.15% and 19.23%, respectively). In comparison to the levels in the fifth grade, it was seen that the representation rate of the skill for classifying increased from 15.90% to 19.23%. Communication skill had a fall by approximately 16%. In terms of ISPS, interpreting data (13.46%), experimenting (9.61%) and modelling (15.38%) skills became prominent. While the skill of experimenting showed a significant decrease in comparison to the previous grade, modelling skill showed a noticeable rise. Similar to the fifth grade levels, skills for formulating hypotheses and operational definition were not represented.

When SPS in the seventh grade science curriculum were analysed, observation and classifying skills became prominent in terms of representation, as in the sixth grade (24.35% and 11.53%, respectively). Additionally, increase in the inferring skills was noteworthy. In terms of ISPS, interpreting data (16.66%) and experimenting (14.10%) skills were the most frequently addressed skills. However, controlling variables showed a significant increase in comparison to the previous grade. On the other hand, there was a significant fall in the representation rate of the modelling variable. Finally, similarly to the levels in the fifth and sixth grades, skills for formulating hypotheses and operational definition were not represented.

**Table 3.** The numbers and percentages of SPS according to grade

| | | 5th Grade | | 6th Grade | | 7th Grade | | 8th Grade | |
|---|---|---|---|---|---|---|---|---|---|
| | **SPS** | *N* | *%* | *N* | *%* | *N* | *%* | *N* | *%* |
| **BSPS** | Observing | 9 | 20.45 | 11 | 21.15 | 19 | 24.35 | 19 | 24.35 |
| | Classifying | 7 | 15.90 | 10 | 19.23 | 9 | 11.53 | 6 | 7.69 |
| | Communicating | 12 | 27.27 | 6 | 11.53 | 3 | 3.84 | 14 | 17.94 |
| | Measuring | 1 | 2.27 | 3 | 5.76 | 3 | 3.84 | 1 | 1.28 |
| | Predicting | 4 | 9.09 | 2 | 3.84 | 2 | 2.56 | 1 | 1.28 |
| | Inferring | 4 | 9.09 | 1 | 1.92 | 6 | 7.69 | 5 | 6.41 |
| **ISPS** | Interpreting Data | 6 | 13.63 | 7 | 13.46 | 13 | 16.66 | 13 | 16.66 |
| | Controlling Variables | 3 | 6.81 | 1 | 1.92 | 5 | 6.41 | 0 | 0 |
| | Experimenting | 10 | 22.72 | 5 | 9.61 | 11 | 14.10 | 4 | 5.12 |
| | Formulating a Hypothesis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Defining Operationally | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Modelling | 4 | 9.09 | 8 | 15.38 | 7 | 8.97 | 5 | 6.41 |
| | Undecided | 5 | 11.36 | 17 | 32.69 | 19 | 24.35 | 27 | 34.61 |
| | Total Learning Outcomes | 44 | | 52 | | 78 | | 78 | |
| | Accumulated Rates | 65 | | 71 | | 97 | | 95 | |

When BSPS in the eighth grade science curriculum were analysed, it was clearly seen that observation (24.35%) and communication (17.94%) skills came to the forefront. While other skills showed similar changes in the rate of representation in comparison to previous grades, the most significant change occurred in the communication skills. Finally, in terms of ISPS, representation rate of controlling variables and experimenting skills decreased significantly compared to the previous grades. As a matter of fact, controlling variables skill was not represented in the learning outcomes at all.

Table 3 showed that the most frequently represented skill among BSPS in fifth grade was communication skill (27.27%). Table 4 shows that this skill may be seen five times in each of the units of “Solving our body puzzle” and “Mystery of earth crust”. Another finding is that measurement skill was almost never represented. In terms of ISPS, mainly the experimenting skill was represented and it became frequent in units of “Change of matter”, “Measurement the size of force”, “Propagation of the light and sound” and “Indispensable part of our lives: electricity”. It is worth noting that these units are usually in the “physical facts” learning domain. It was seen that the skill of modelling, on which most of the students have broad misconceptions, was represented in the units of “Propagation of light and sound”, “Visit the world of living beings” and “Indispensable part of our Lives: electricity”.

Table 4. The numbers and percentages of SPS according to units

| Grade Level | Unit number | Unit | Total learning Outcomes | Observation | Classifying | Communicating | Measuring | Predicting | Inferring | Interpretation | Controlling variables | Experimenting | Formulating a hypothesis | Defining operationally | Modelling | Other | Accumulated |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 1 | Solving our body puzzle | 13 | 4 | 1 | 5 | - | - | 2 | 2 | - | - | - | - | - | 2 | 16 |
| | 2 | Measurement the size of force | 2 | - | 2 | - | 1 | - | - | - | 1 | 2 | - | - | - | - | 6 |
| | 3 | Change of matter | 6 | 1 | 1 | 1 | - | - | 1 | 3 | 1 | 4 | - | - | - | - | 12 |
| | 4 | Propagation of the light and sound | 7 | 2 | 1 | - | - | 2 | 1 | - | - | 2 | - | - | 2 | - | 10 |
| | 5 | Visit and identify the world of the living beings | 3 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | - | 4 |
| | 6 | Indispensable part of our lives: electricity | 3 | - | - | - | - | 1 | - | - | 1 | 2 | - | - | 1 | - | 5 |
| | 7 | Mystery of the Earth's crust | 10 | 1 | 1 | 5 | - | 1 | - | 1 | - | - | - | - | - | 3 | 12 |
| | | | 44 | 9 | 7 | 12 | 1 | 4 | 4 | 6 | 3 | 1 | 0 | 0 | 4 | 5 | 65 |
| 6 | 1 | Systems in our bodies | 14 | 5 | 1 | 3 | - | - | - | 4 | - | - | - | - | - | 4 | 17 |
| | 2 | Force and motion | 6 | 2 | 1 | - | - | - | 1 | 1 | - | - | - | - | 2 | 2 | 9 |
| | 3 | Granular structure of matter | 7 | 1 | 2 | - | 2 | - | - | - | - | 2 | - | - | 1 | 3 | 11 |
| | 4 | Light and sound | 5 | 1 | - | - | - | 1 | - | 1 | - | 1 | - | - | 1 | 2 | 7 |
| | 5 | Reproduction, growth development in human beings | 4 | - | 1 | - | - | - | - | - | - | - | - | - | - | 3 | 4 |
| | 6 | Matter and heat | 7 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 1 | 8 |
| | 7 | Electricity in our lives | 5 | - | 1 | - | 1 | 1 | - | - | 1 | 2 | - | - | 1 | 2 | 9 |
| | 8 | Our earth, moon and source of our lives: Sun | 4 | - | 2 | 1 | - | - | - | 1 | - | - | - | - | 2 | - | 6 |
| | | | 52 | 11 | 10 | 6 | 3 | 2 | 1 | 7 | 1 | 5 | 0 | 0 | 8 | 17 | 71 |

**Table 4.** The numbers and percentages of SPS according to units(*Continued*)

| Grade Level | Unit number | Unit | Total learning Outcomes | Observation | Classifying | Communicating | Measuring | Predicting | Inferring | Interpretation | Controlling variables | Experimenting | Formulating a hypothesis | Defining operationally | Modelling | Other | Accumulated |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 1 | Systems in our bodies | 16 | 7 | 1 | - | - | - | - | 4 | - | 1 | - | - | 1 | 3 | 17 |
| | 2 | Force and energy | 9 | - | 2 | 1 | 1 | - | 1 | 3 | 2 | 2 | - | - | - | 3 | 15 |
| | 3 | Structure and properties of matter | 22 | 1 | 3 | - | - | 1 | - | - | 1 | 3 | - | - | 4 | 6 | 19 |
| | 4 | Reflection in mirrors and absorption of Light | 6 | 3 | 1 | - | - | - | 1 | 1 | - | - | - | - | - | - | 6 |
| | 5 | The relationships between humans and the environment | 4 | 1 | - | - | - | - | - | 1 | - | - | - | - | - | 2 | 4 |
| | 6 | Electrical energy | 12 | 4 | - | 2 | 2 | - | 3 | 3 | 2 | 5 | - | - | 1 | 3 | 25 |
| | 7 | The solar system and beyond | 9 | 3 | 2 | - | - | 1 | 1 | 1 | - | - | - | - | 1 | 2 | 11 |
| | | | 78 | 19 | 9 | 3 | 3 | 2 | 6 | 13 | 5 | 1 | 0 | 0 | 7 | 19 | 97 |
| 8 | 1 | Reproduction in humans | 13 | 4 | - | 3 | - | - | - | 4 | - | - | - | - | - | 4 | 15 |
| | 2 | Simple machines | 3 | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 2 | 4 |
| | 3 | Structure and properties of matter | 16 | 4 | 3 | 2 | - | 1 | 2 | - | - | - | - | - | - | 7 | 19 |
| | 4 | Light and sound | 6 | 2 | 1 | - | - | - | - | 1 | - | 1 | - | - | - | 3 | 8 |
| | 5 | Living beings and energy relations | 11 | 4 | - | 3 | - | - | - | 3 | - | - | - | - | 1 | - | 11 |
| | 6 | States of matter | 7 | - | - | - | 1 | - | 2 | 3 | - | - | - | - | 1 | 2 | 9 |
| | 7 | Electricity in our lives | 6 | 3 | 2 | 1 | - | - | - | - | - | 2 | - | - | 1 | - | 9 |
| | 8 | Earthquakes and weather events | 16 | 2 | - | 5 | - | - | 1 | 2 | - | - | - | - | 1 | 9 | 20 |
| | | | 78 | 19 | 6 | 14 | 1 | 1 | 5 | 13 | 0 | 4 | 0 | 0 | 5 | 27 | 95 |

In analysing the BSPS in the level of sixth grade, the learning outcomes related to observation were frequent especially in the "Systems in our bodies" unit. This unit included observation and communication skills among BSPS. When the learning outcomes in the same unit were investigated, it was observed that it only focused on the integrated skill of interpretation. In comparison to previous grades, it may be stated that the modelling skill was spread to the units in a more orderly fashion. Modelling skill mainly resided in the "physical facts" sub-domain of learning. The unit of "Matter and heat" did not address any ISPS except a single occasion of modelling. No units except "Force and movement" addressed the skill of "inferring". Similarly, the skill of predicting was seen once in each of the "Light and sound" and "Electricity in our lives" units only. Considering ISPS, controlling variables skill was addressed only one time in the "Electrical energy" unit. No skill except classifying was seen in the unit of "Reproduction, growth and development in plants and animals". Similarly, this unit did not include any learning outcomes regarding ISPS.

Considering BSPS in the level of seventh grade, it was seen that the skill of observation was spread among almost all units in a uniform way. It was observed that the skill of observation was frequent especially in the unit of "Systems in our bodies". The learning outcomes in the unit of "The relationships among human and environment" were insufficient in terms of both basic and integrated SPS. Despite the insufficient nature of the unit of "Reflection in mirrors and absorption of light" just like in the previously mentioned unit, the observation skill was mentioned at least in three learning outcomes. It was found that the unit of "Force and energy" showed an equal distribution in terms of BSPS, while "Electrical energy" unit was distributed equally in a way for both basic and integrated SPS.

When skills on the level of eighth grade were analysed, the observation skill was distributed evenly, in similarity to the previous grade. The communication skill was also distributed evenly. It was seen that measurement and prediction skills were almost never represented. The "Light and sound" unit did not show an equal distribution in terms of BSPS. No learning outcome addressing BSPS was found in the "Simple machines" unit. Similarly, it was also seen that experimenting and modelling skills were found only once. The unit of "Structure and properties of matter" focused especially on BSPS. While the learning outcomes in this unit showed a balanced distribution in terms of BSPS, no outcome included any of ISPS, as well.

## Discussion, Conclusion and Suggestions

We discuss here the results in terms of our research questions. Going further, it is investigated to what extent SPS vary according to grade level and distributed throughout the units in science curriculum. Consequently, the purpose of the present study was to investigate both adequacy and distribution of SPS belong to the units including learning outcomes given in science curriculum. Therefore, the analysis pertaining to the distribution of SPS was primarily at the focus of the study. The total number of learning outcomes in science curriculum was determined as 44 in the fifth grade, as 52 in the sixth grade, as 78 both in the seventh and eighth grade. Consequently, it can be concluded that there is a regular increase of learning outcomes as grade level gets higher. In addition, SPS varied in number as basic and integrated skills in terms of grade level. In detail, SPS were dispersed over six BSPS totally 37 times in the fifth grade, 33 times in the sixth grade, 42 times in the seventh grade and 46 times in the eighth grade. Similarly, ISPS were 14 times in the fifth grade, 21 times in the sixth grade, 26 times in the seventh grade and finally 22 times in the eighth grade as given in Table 3.

Some empirical studies have shown that the representation rate of SPS for both science curriculums and science textbooks vary with grade level and unit (Dökme, 2005; Koray et al., 2006; Şen & Nakiboglu, 2012; Yıldız Feyzioglu & Tatar, 2012; Aslan, 2015). In the present study, we operated a qualitative analysis that assessing the learning outcomes in science curriculum according to standards-based criteria (sentence-based criteria, as mentioned before) that researchers reconciled with each other and come to an agreement as far as possible. This analysis proceeded further investigation of both BSPS and ISPS. At the end of the analysis, we reached a similar result with abovementioned studies as the representation rate of SPS for science curriculum varies with grade level and units. More specifically, evidence in the present study also suggests that the representation rate of controlling variables as ISPS decreases remarkably in the eighth grade in comparison to that of seventh grade. This result is supported by several studies. Ağgül Yalçın (2011) found out that controlling variables does not exist in any issues of Primary Eighth Grade Science and Technology Teacher Guide Book. In their study, Koray et al. (2006) carried out a content analysis of SPS both in the course books of chemistry and chemistry curriculum at ninth grade. Results indicated that the skill of controlling variables is not included both in the science curriculum and science textbooks. However, science curriculum and science textbooks are quite sufficient in terms of "interpreting data" and "experimenting" while chemistry curriculum at ninth grade level does not represent these skills sufficiently. This result is implicitly supported by Beaumont-Walters & Soyibo (2001) with their studies concluded that students are more competent in the skill of interpreting data in comparison to formulating hypothesis and identifying variables. Contrary to the result of Koray et al. (2006) on the basis of curriculum, the present study concluded that science curriculum represents those two skills sufficiently. On the other hand, Böyük et al. (2011) point out that the skill of classification is represented at most while controlling variables and experimenting at least. The present study reached a similar result with Böyük et al. (2011) in terms of the skill of classification and controlling variables whereas both studies conflicted with regard to the skill of experimenting. Yıldız Feyzioglu & Tatar (2012) conducted a comprehensive document analysis of activities in elementary science textbooks including SPS. The analysis showed that some of the textbooks do not include SPS taking part in the science curriculum. More specifically, the study indicated that formulating hypothesis is rarely represented in the textbooks. This result is also confirmed in the present study. Moreover, it is worthy to conclude that none of the learning outcomes investigated during the analysis were referred to formulating hypothesis. This result is implicitly supported by the studies conducted by Ağgül Yalçın (2011) and Sinan & Usak (2011) in which they put emphasise on the fact that formulating hypothesis is not sufficiently represented and put into effect. The skill of communication has a high rate of representation except in seventh grade. This result is confirmed by various studies (Bagcı Kılıc et al., 2008; Ağgül Yalçın, 2011). In other respects, previous studies tenaciously advocate that the skill of observation is represented at the highest rate in various contexts and considered as a milestone or a gateway to combine BSPS with ISPS in a developmental sequence (Aziz & Zain, 2010; Sen & Nakiboglu, 2012). The present study also supports this result excluding the representation rate of observation in fifth grade to go beyond in quantity and surpassed by the skill of communication.

In the present study, in addition to the analysis based on grade level, outcomes were also analysed in terms of units. As a result, it is worth noting that the experimenting skill, which was the most frequently addressed skill on level of the fifth grade, was most frequently seen in units on "Changes in matter", "Measuring the magnitude of force", "Propagation of light and sound" and "Indispensable part of our lives: electricity", and these units are mainly in the learning sub-domain of "physical events". In the data of the sixth grade, it was seen that no integrated skills were included in "Matter and heat" unit, where students have many misconceptions. However, this unit is where students have the highest amount of misconceptions among others. This result was confirmed by many studies (Chu, Treagust, Yeo, & Zadnik, 2012; Lee, 2014; Wong, Chu, & Yap, 2014). As a result of studies where various methods were tried in order to eliminate misconceptions, it was seen that misconceptions were resistant against change and they were affected by different contexts (Niaz, 2000). This situation necessitates students' adequate possession of both basic and integrated SPS and usage of these skills in steps of conceptual learning. Analysis of the seventh grade data resulted in contradicting features in different units. For instance, while the unit "Electrical energy" had a balanced distribution in both basic and integrated SPS, the unit "The relationships among human and environment" was inadequate in both sets of skills. According to the data of the eighth grades, in similarity to the previous grades, it may be seen that ISPS were insufficient. This result is conflicted with the studies advocating that SPS included in science curriculum gradually increase in number from the first grade to next ones. Additionally, it was found that measurement and predicting skills' representation rates were still at low levels (Yılmaz Senem, 2013).

SPS could be thought as moderators that activate students to inquiry about a body of scientific knowledge in the pursuit of increasing academic achievement (Aziz & Zain, 2010). Recent research has shown that there is a significant positive correlation between academic achievement and SPS (Berman, 1996; Walters & Soyibo, 2001; Aktamıs & Ergin, 2008; Sinan & Usak, 2011; Delen & Kesercioglu, 2012). In addition, both SPS and academic achievement are often regarded as interrelated to the process of conceptual change. Therefore, in order to develop a high-level conceptual change, SPS are so important that they are inseparable part of conceptual change and conceptual understanding (Karamustafaoglu, 2011). In conclusion, SPS can be seen as a set of factors that supporting conceptual understanding because of its correlation with academic achievement. Despite its importance on the conceptual understanding as mentioned, an increasing number of studies result in students both from primary and secondary school are found not to have adequate SPS included in science curriculum (Aydogdu, 2006; Hazır & Türkmen, 2008; Delen & Kesercioglu, 2012). In addition, some empirical studies pointed out that both students and preservice teachers are more competent at BSPS than integrated ones (e.g. Beaumont-Walters & Soyibo, 2001; Koray et al., 2007; Aslan, 2015; Aydogdu, 2015). Accordingly, Lacin Simsek (2010) and Aydogdu (2015) found similarity to the findings in the literature that, preservice teachers also experienced such problems regarding insufficiently represented SPS skills. When the results of the study conducted by Aydogdu (2015) are reviewed, it may be seen that the opinions of preservice science teachers vary in terms of what SPS are and what they are for. This situation, directly or indirectly affects both the preservice practices of prospective teachers, and the in-class practices of active teachers. Improvement of the SPS possessed by teachers is in practice based on the frequency of usage of these processes in the practices utilised during teaching (Aydogdu, 2015). In the stages of including the outcomes in the curriculum in the schedule and teaching in terms of this plan, teachers and prospective teachers who find themselves inadequate in terms of SPS may sometimes focus only on the skills they consider themselves adequate in, and ignore activities and practices especially related to ISPS they experience difficulties in.

Aslan (2015) investigated the activities included in middle school science textbooks and found that most of these activities were at a starting level. It is frequently stated in the studies investigating the levels of middle school students in SPS that students are better in BSPS (Böyük et al., 2011). Considering these results in connection, it is an expected result that students who receive education based on improving their BSPS will show higher performance in BSPS, while experiencing difficulties in ISPS. Similarly, it was seen in this study that the outcome in the sciences curriculum also mainly included BSPS rather than ISPS. This suggests that there are problems in establishing integrated process skills. This may be considered in both positive and negative approaches. It is important that BSPS are adequately represented in terms of both students, and curriculums and related activities, as they precede the improvement of ISPS. Students possessing BSPS will have the opportunity to improve their ISPS with the help of these skills. However, the research findings regarding the information obtained about inadequacy of teachers, students, science textbooks and science curriculum in ISPS, are troubling about the uncertainty regarding the state of students currently receiving education in these grade levels.

Yıldız Feyzioğlu & Tatar (2012), who provided a different reason during the investigation of the skills where some problems and inadequacies are experienced in practice in terms of SPS as indicated in many studies including this one, approached the issue in terms of open-endedness. Researchers investigated SPS in textbooks in terms of open-endedness; found that the rates of open-endedness in the skills of “determining variables” and “controlling variables” were lower than those in other skills. In addition, it is among the results of the research that high-level skills had lower rates of open-endedness in comparison to other skills in general. Similar findings were obtained regarding SPS and it was reported that these skills had close-ended structures. It was also seen that students did not use hypothesis formulation skills. Providing activities or all science process elements in these activities in an implicit form may create problems regarding students’ usage of their creativity. That’s why imagination and creativity are highly important in obtaining scientific information. It is natural for students who do not use their imagination and creativity to see scientific information as a bunch of knowledge that is arising as a result of a universal method which is accepted without any terms or conditions. It may be argued that students who do not take an active part in producing information may have the impression that information will not change and therefore they do not need ISPS that are related to self-cognition, especially hypothesis formulation, defining and controlling variables, operational definition and modelling. Considering all these facts, it may be understood that producing information by induction rather than deduction, and providing data for ISPS by the information obtained via BSPS in this process, is highly important for the development of students’ SPS. Considering the fact that the mentioned skills also pose problems in terms of the science curriculum due to the findings of this study, it may be stated that the dysfunctional and problematic parts of in-class SPS activities are affected by the general structure of the science curriculum, and starting with the curriculum, issues are reflected to class schedules, learning outcomes and in-class activities. In other words, one may generalise that the productivity of in-class activities, in addition to many other factors, is affected by how explicitly and flexibly the science curriculum is prepared in terms of SPS. Therefore, SPS in a science curriculum should be investigated in terms of their open-endedness and how feasible they are for development of activities that are suitable for open-endedness.

Although our study is among the first to analyse the representation rate of the learning outcomes related to SPS included in the science curriculum in line with grade level and unit, there are also some limitations in view of the results reached in the current study. The first limitation of the present study seemed to have utilised science curriculum revised in 2013 as data source. There exist a number of studies already mentioned in the given literature that used a variety of sources including science textbooks and teacher guide books in order to examine SPS. Additionally, the analysis was operated by only assessing the learning outcomes with criteria rather than the assessment of science activities or the perceptions of both teachers and students with regard to SPS. The second limitation could be seen as the fact that the representation rate of SPS were calculated as accumulated frequencies to the extent researchers have agreed upon the criteria based on the standards-based assessment. The possible lack of attention in the course of categorization process may have a disturbing effect and therefore some of SPS were incorrectly coded into the learning outcomes. The last limitation of the study is about the learning outcomes in number and percentages. Naturally, it is not expected that all the units in the science curriculum to have the same number of learning outcomes. Some of them have an intense content and then they have more learning outcomes than others. Therefore, it is important to take into consideration for readers to evaluate the numbers and percentages in the tables along with the thought of each learning outcome may represent the units having different intensity of content in the science curriculum.

To sum up, it is worth mentioning that students, teachers and the science curriculum show inadequacy in terms of integrated science process. Reasons for this issue and possible methods of solution should be investigated by further explanatory studies. SPS should be advanced by each grade level, and distributed evenly through all the units. This requires better attentiveness while preparing science curriculum. While the learning outcomes included in the curriculum are determined as a necessity of outcome-based analysis, outcome expressions should be given in a form that represent or remind SPS in order to ensure better understanding of that they refer to SPS. When 2013 Science Curriculum is compared to the curriculum of 2005, there is a noticeable decrease in terms of the number of the learning outcomes. Thus, applied implementations may be organised to develop activities with the purpose of eliminating the possible shortcomings of the curriculum of 2013 in terms of developing SPS. Consequently, the outcomes in the curriculum should be made more explicit. As a matter of fact, in establishing and determining outcomes, in addition to the experts of curriculum developments, teachers may also be allowed to take initiatives as active practisers of the process. Teachers should be able to make flexible changes to lesson plans and the outcomes assigned compulsorily to these plans without leaving a specified taxonomy, so that they are able to satisfy the requirements of active learning classes by satisfying the long term needs of students, as well as their spontaneous needs.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Notes on contributors

**Umit Duruk** – PhD in Science Education, Research Assistant, Department of Science Education, Adıyaman, Turkey.

**Abuzer Akgün** – Doctor of Chemistry Education, Associate Professor, Department of Science Education, Adıyaman, Turkey.

**Ceylan Doğan** – Master Student in Science Education, Science Teacher, Ministry of National Education, Adıyaman, Turkey.

**Fatma Gülsuyu**– Master Student in Science Education, Adıyaman, Turkey.

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