

PRE-SERVICE PRIMARY SCHOOL TEACHERS' KNOWLEDGE OF SCIENCE PROCESS SKILLS AND HOW THEY INTEGRATE THESE SKILLS INTO LESSONS

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ABSTRACT

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The purpose of this study is to monitor the development of pre-service primary school teachers' knowledge of science process skills and how they integrate these skills into their lessons. Towards this end, the study was designed with the method of the interpretive case study. The sample of the study consists of 3 pre-service teachers who are studying in their last semester and attending primary school within the teaching practice course. In the study, the focus group interview was held with the pre-service teachers twice before and after the process. Finally, changes in lectures have been observed in the direction of informing the pre-service teachers about science process skills. Content analysis was used for the qualitative data obtained in the study. In the study, it was seen that the pre-service teachers' knowledge levels towards science process skills increased and they were progressing in integrating these skills into their courses.

Keywords: Pre-service primary school teachers, Science process skills, Interpretive case study.

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INTRODUCTION

Technology and knowledge have undeniably improved in recent years. These developments affect every aspect of life. Education, which is an important element of life, has received a large share from these developments. With the advancement of technology and knowledge, it has become an important issue to train individuals who adapt to these innovations and to transfer competencies to use skills. The change in the education system brought along skills such as critical thinking, questioning, problem-solving, and conveying the events that take place in daily life. These skills shaped the science curriculum.

One of the goals of the science curriculum is to take responsibility for the problems encountered in daily life and to use knowledge, science process skills (SPS) and other life skills in solving these problems (Ministry of National Education [MoNE], 2013). In this curriculum, it is often emphasized the importance of raising individuals having SPS with scientific literacy and the use of teachers' questioning method as a teaching method during the lesson. While dealing with questioning, students explain objects and events, ask questions, make explanations, test these explanations against existing scientific knowledge, and share their ideas with others. They determine their assumptions, use critical and logical thinking, and think of alternative explanations. Thus, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills (National Research Council [NRC], 1996). Anderson (2002) states that SPS constitute an important part of scientific inquiry and improve scientific literacy in students accordingly. It enables students to learn SPS and to transfer them to daily life permanently. Testing the knowledge in every field gives students self-confidence and prevents possible misconceptions thanks to looking at the subject critically. As well as students, teachers and pre-service teachers need to master SPS. Michaels, Shouse and Schweingruber (2008) argued that teachers should create scientific learning opportunities for their students and be able to relate science language and learning life to real life events. Also, teachers should encourage their students to use these skills. Chiappetta (1997) stated that acquiring and using these skills can help students become more equipped to solve problems, learn on their own and appreciate science.

On the other hand, raising scientifically literate individuals is not possible by transferring information directly to them, but by enabling them to access scientific information themselves. In this context, SPS are important in terms of teaching ways to access information (Yuenyong & Narjaikaew, 2009). It is also very important to encourage students to use SPS. Science process skills should be taught to students not only as a discipline but also as a lifelong skill and its importance should be emphasized. Teachers and pre-service teachers must have an effective level of knowledge in teaching these skills. Because, if the teachers and pre-service teachers do not fully master this information, they may convey missing or incorrect information to the students.

Ornstein (2006) stated that the importance given to teaching SPS depends on the importance teachers put onto the SPS. The most important factor achieving the desired student development is the quality of the teacher, the teaching method and the assessment of the teacher. Therefore, it is necessary to plan the education process well for teachers to gain competence in comprehension and curriculum development, teaching management, assessment and evaluation activities. Therefore, pre-service teachers must gain experience in teaching science and meet the needs of students while transferring information. Warnich and Meyer (2013) think that

general skills and SPS are equally important for teacher education. Hence, both skill groups should be included in teacher education. From this point of view, it can be concluded that teachers should have a high level of SPS. Teaching the SPS and their importance to the pre-service primary school teachers fully enables them to convey the skills they will teach in the best way possible. For this reason, future teachers should improve these skills efficiently. Also, SPS form the basis of science. It enables individuals to conduct research and draw conclusions. It is thought that putting these skills into practice in the class and training pre-service teachers in this area haven't been realized yet (Tifi, Natale and Lombardi, 2006). In this context, this research is important in terms of teaching pre-service teachers the SPS and putting them into practice.

Pre-service teachers can adapt their conceptual understanding to new and daily life situations that include SPS. On the other hand, it is important for pre-service teachers to have a solid conceptual understanding and to be able to properly perform test items containing new aspects of SPS to effectively create an atmosphere supporting development among their students (Chabalengula, Mumba & Mbewe, 2012). Therefore, this study aims to monitor the development of pre-service primary school teachers' knowledge of science process skills and how they integrate these skills into their lessons.

METHOD

Research Design

The research was designed with the interpretive case study method, which is one of the qualitative research designs. Schwartz-Shea (2006) explained it as follows:

“A central goal of interpretive approaches is understanding human meaning making; issues of causality are not necessarily excluded but are understood much differently than in the variables gestalt.... Being attuned to meaning making involves a recognition of, and sensitivity to, the ambiguities of human experience; researchers presuppose that meanings are negotiated and constructed, and they often deliberately investigate efforts to promulgate or resist particular meanings, at the same time that they explore the variation of meanings across contexts (p. 123).”

Study Group

The study group of the research consists of 3 pre-service teachers (2 females, 1 male) who are studying in the last year of a public university. Purposeful sampling method was used in the study. First of all, while selecting the study group, 10 pre-service teachers who went to primary school were chosen within the scope of teaching practice course because of the high level of emphasis on SPS within the context of science course. Then, 3 volunteer pre-service teachers were included in the study.

Data Collection Tools

Semi-structured "Focus Group Interview Form", "Lesson Plans" and "Observation Form" were used as data collection tools in the research.

Semi-structured focus group interviews were made with pre-service teachers before and after the process. After examining the pre-service teachers' knowledge on the subject; questions were created, examined by three field experts, and they were asked to pre-service teachers in their final form.

In order to determine the knowledge of pre-service teachers, they were asked to select a subject from the 4th-grade unit and topics and to prepare a lesson plan at the beginning of the study. This lesson plan helped to determine the problem status of pre-service teachers. Lesson plans were analyzed to determine whether pre-service teachers used SPS during the lessons.

An observation form was created for the lessons in the university and elementary school, and the pre-service teachers were observed while teaching at the macro and micro level. After giving the final form to the observation form examined by three field experts, pre-service teachers were observed by the practitioner during the lessons. The skills used by pre-service teachers were written in detail in the observation forms during each lesson.

Data Collection Process

The applied front focus group interview was recorded with the camera. After these practices, pre-service teachers were asked to prepare a lesson plan and integrate their SPS into their plans to see how they transferred their SPS to the science course and what level of knowledge they had about the application. Lesson plans were examined, and a plan was created regarding the information provided to the pre-service teachers. Pre-service teachers were informed about SPS with slides and videos. After the information provided, pre-service teachers started to transfer lessons, in which they integrate their SPS in the university environment. The researcher observed pre-service teachers one by one recorded the lessons with the camera and used the observation form during the lessons. The lesson, the shortcomings and the things to be done were discussed and information was given at the missing points again at the end of each lesson.

After the lessons in the university environment were finished, the pre-service teachers, who were given feedback and tried to be perfected, continued their lessons at the primary school where they are practicing teaching. Each pre-service teacher was given one course hour and the practice lasted 3 weeks. All of the lessons were recorded on the camera and examined with an observation form.

After briefings and lessons, the focus group discussion was made and changes in the process were tried to be taken into account. The last focus group interview was also recorded on the camera by the researcher.

Data Analysis

Content analysis from qualitative research method was used to analyze the data obtained in the research. Content analysis is typically textual analysis of a data set that includes comparison, contrasting and categorizing data, and dividing them with differently defined themes and concepts (Fraenkel & Wallen, 2000).

The data were tried to be analyzed by combining similar data within the framework of certain concepts and themes in the focus group interviews. Answers were examined by 3 field experts

and the common answers were analyzed. Important points in the analysis of focus group interviews, knowledge levels of pre-service teachers concerning SPS, and to the degree of using them in the lessons were taken into consideration, and the data expressed in full were collected as adequate. The answers given with incomplete and inaccurate expressions were taken as inadequate.

In order for the research to be reliable, it is necessary to constantly participate in the working environment and the process, and to monitor the process in person and observe. Additionally, it is necessary to obtain information from other researchers and experts to compare various data sources and to control them in different ways, to collect data, to provide documentation, video and audio recording, and to provide structural support and consistency (Mills, 2007). A number of measures have been taken to ensure the validity and reliability of the study.

To ensure internal validity, the researcher needs to be consistent in analyzing and interpreting the data collection process and how this consistency is achieved. More than one data collection tool was used to ensure internal validity in this study. Interview data were analyzed with the help of field experts. Expert opinions were taken for the interview and observation forms developed in the research. It was noted that the findings are meaningful and consistent in themselves and that the data obtained from different data sources form a whole.

The results were compared by analyzing the data with the help of two field experts to ensure internal reliability. The data obtained in observation and interview are explained directly with quotations. Findings obtained with different data collection tools were compared and evaluated.

Participants in the study, the research environment and the process have been described in detail to compare them with other samples to ensure external reliability. Besides, data collection and analysis methods are mentioned in detail. Moreover, it was explained in detail how to interpret the findings and how to reach the results.

FINDINGS

Focus Group Interviews

Regarding the purpose of the research, a focus group interview was held to pre-service teachers before the process. After the process was completed, a focus group interview was held again to examine how the ideas about information and concepts changed. The findings were examined under two different headings.

First interview about SPS

Regarding SPS, Ali said: *"I have no knowledge, but I have an opinion. It is mostly used in science. I think SPS were to prove our questions with some experiments within certain systems. It is important to make the student active in the process."* He also stated that he did not teach the course by considering the SPS, but that it is important and useful to associate a problem with daily life.

Duru mentioned that she was not very sure about SPS, but she remembered that there should be a problem, and a goal should be determined to solve the problem, hypothesising,

experimenting, code and law. Respecting the lesson plan she prepared, she gave the following answer:

"I set out with the goal of what I want to give them. Then I tried to give them examples with questions and examples. Based on the example, they would separate them into mixed and pure substances."

Irmak stated that she remembered prediction and observation among SPS. She added that she paid attention to problem-solving and experimenting while preparing the lesson plan.

Considering the answers given at the end of the first focus group interview, it is seen that the pre-service primary school teachers do not fully master the SPS. In terms of their knowledge about SPS and deficiencies in transferring SPS to the lesson plan, they were found to be inadequate. This showed that their command of SPS was insufficient. It was determined that they did not realize whether they applied SPS in the classes. They are thought to confuse or forget SPS. In this regard, it is seen that pre-service classroom teachers have little knowledge of SPS.

Second interview about SPS

Ali saw the differences between the first lesson plan he prepared and the last lesson plan he prepared.

"At least I know what to do, how to put them in order. I can handle my lesson by sticking to the lesson plan more. I have no question mark in my mind whether there's a learning outcome or not. Also, children give very good feedback. I noticed that the question marks in their minds disappear over time."

He emphasized that it is important to allow students to make operational definition. He also added that he focused on observing and experimenting, classification, and operational definition while preparing the lesson plan.

Duru was asked about her views concerning the process, in which she was informed about SPS and got to make practice.

"At first I realized that I did not know what SPS were. I was not aware that I did not know. I can give the lesson plan to the children better and easier when I prepare the lesson according to SPS and I think students understand it better this way. I can also make the teaching order of the lesson more accurate. I haven't even known what measuring is. I've learned what that is."

While preparing the lesson plan, she stated that she tried to use prediction, observation and classification more which helped her to prepare a better and understandable lesson plan.

Irmak declared that she did not know the SPS and realized that she had insufficient information.

"I realized that I didn't know anything about SPS because we couldn't answer the questions about SPS. It only occurred to us making hypothesis and experimenting. First, we saw here which ones are missing, how and where they are used. We didn't know any of them. As Ali said, I realized that it was very different when we paid attention to these. Inference, observation,

prediction are applied. Both students are active, and you get answers, thoughts and everything from them. I think it's better in every way."

Irmak mentioned that she used operational definition a lot and that she had not allowed students to make a definition before that. Concerning the lesson plan, she was careful to use classification, observation, inference, and experiment. Regarding the pros and cons of this process, which aims to integrate SPS into lessons, she gave the following response:

"We were ashamed of our previous knowledge. We learned many things we had not known. From now on, it will help us a lot in planning a lesson."

Considering the answers to the second focus group meeting, it is seen that this process was effective for pre-service teachers. Pre-service teachers applied SPS with awareness both while learning and integrating the course. It was observed that they showed a positive development in transferring knowledge regarding SPS and definitions. In line with these answers, it is seen that pre-service teachers learned the SPS at a sufficient level. Because pre-service teachers could only express 3 of the SPS at the first focus group meeting. The last focus group interview revealed that they were able to express almost all of the SPS.

Observations

The lessons of the pre-service teachers were examined in detail with observation forms and camera recording. The findings were analyzed under two different titles as the integration into the courses in the preliminary assessment and the integration into the courses in the final assessment.

Pre-service teachers' integration of SPS to their lessons in first lessons

The first lessons of pre-service teachers showed that they made little use of SPS. It is seen that they used the skills of making experiments and predictions, operational definition and classification. As it is understood from the first focus group interviews, pre-service teachers also focused on experimenting skills in lessons as they defined SPS as skills such as experimenting and problem-solving. They prepared an experiment-oriented course and conducted their courses within the framework of these experiments. The ability to make predictions was used for the results of the experiments.

The opinions of all pre-service teachers were collected on what was done about the lesson, which skills were missing and what other SPS could be used in this lesson at the end of each lesson. In line with these, recommendations were given on the SPS used by pre-service teachers incomplete or incorrect, and information was provided over the examples for the pre-service teachers to understand the SPS better. It was found that pre-service teachers were not at a sufficient level to integrate SPS into their lessons.

Pre-service teachers' integration of SPS to their lessons in second lessons

Considering the SPS used in the second lesson, it is observed that there is a great increase. It is seen that the skills such as communication, inference, operational definition, measurement that are not used in the first lesson began to be used after the process. As the pre-service teachers

understand the knowledge of the concepts better, these skills were transferred to their lessons better, and these skills were transferred better with the correction of deficiencies and mistakes as a result of the applications. Thanks for explaining how the skills that they did not use before should be transferred and giving examples, they use the skills better in the lessons. The results indicated that Ali and Irmak can transfer sufficient SPS to their lessons, while Duru has integrated it at an intermediate level.

DISCUSSION AND CONCLUSION

It was found that pre-service teachers' knowledge of SPS were very low and there were many misconceptions about these skills. It was found that this misconception was in the measurement skill. The Pre-service teachers said they think that measuring is done to measure students' level of knowledge. They were relieved of this error when explained measurement is through standard or non-standard measurement tool of the weight, length and volumes. Increase in their knowledge on practices during lessons and absence of misconceptions were to be realized at the second focus group.

In the first focus group meeting with pre-service teachers, it was found that their knowledge of SPS was incorrect or incomplete. When asked what they know about the SPS, they mentioned the skills such as observation, experiment, hypothesis, as well as offering solutions, reaching the law through theories. However, it was determined that their knowledge about SPS was incomplete. Mbewe, Chabalengula and Mumba (2010) found in a study that almost all pre-service teachers were unable to accurately describe and explain the basic and integrated SPS, but the majority of them were partially correct and incorrect. It was observed that the pre-service teachers in the study did not have enough information to help future students understand the SPS in a meaningful way.

Pre-service teachers were asked to make a lesson plan suitable for SPS. When asked which science process skill's stages they paid attention, they said that the lesson should include giving examples, posing problems and problem-solving stages. In the plans they prepared with the imperfect knowledge, it was seen that they were not aware of exactly what they should pay attention to, that is, they did not have complete knowledge of SPS. Işık and Nakipoğlu (2012) also found that teachers do not have a good command of SPS and do not receive training on SPS. Similarly, Turkmen and Kandemir (2011) found that teachers do not have clear knowledge about SPS, which are widely included in the 4th and 5th-grade science curriculum. It is observed that pre-service teachers who graduated with insufficient and incorrect information by creating a domino effect in the education system cannot fully apply the SPS and even the knowledge is incomplete when they become teachers.

When asked if they used SPS in lessons, they said they might have used it without realizing. It was also noticed that pre-service teachers were inadequate in transferring SPS to daily life. The reason for asking this question is to make pre-service teachers realize that SPS are not only skills used in science. Harlen (1999) defined these skills as not only specific to science, but general cognitive skills that can be acquired when people engage in ordinary everyday activities. Therefore, directing pre-service teachers to the teaching and use of these skills throughout their future lives and teaching careers is important.

After the process was completed, a focus group meeting was held with pre-service teachers again. When asked how pre-service teachers were affected by the process, it was observed that they realized they did not know the SPS, but afterwards, they were comfortable in the lesson process and the students were more active in the lesson. Based on this result, it is seen that pre-service teachers are positively affected by the practices.

When asked about the stages of SPS, it was observed that they reached more correct concepts even though they had few deficiencies, and they were more confident in saying these. When asked about which stages, they paid attention to in the process, they realized that they had misconceptions in the measurement phase and said that it was an important step to let the students make definitions. Thus, it is seen that they learn these stages better. Also, it is seen that pre-service teachers remember the skills they use in lessons much better than the others. It can be said that the practiced information provides more permanent learning. In their study with pre-service primary school teachers, Şimşekli and Çalış (2008) asked questions to them regarding their knowledge on SPS and found that most of them did not respond correctly. Besides, it was observed that many of the questions regarding observation skills were answered incorrectly at the end of the year. As a result, they said that SPS should try to be improved by practices. When asked to define the SPS, it is seen that they make definitions suitable for SPS by considering their knowledge and practices. They also stated that they realized this when they used a skill that was transferred to daily life.

It was observed that pre-service teachers could not fully apply or use SPS in their first lessons. Observation results showed that they used these skills inadequate and could not fully integrate them into the lessons. Addressing the identified shortcomings, it was tried to help them improve by giving feedback. It was seen that they had more control over the subject and tried to overcome their shortcomings in the second lessons. Looking at the overall lessons, pre-service teachers improved themselves and reached a sufficient level to integrate these skills into lessons. It was observed that pre-service teachers integrated SPS easily by increasing their knowledge and reinforcing practices and skills. Gürses, Cuya, Güneş, and Doğar (2014) support the idea that university students' practice potential should be increased to raise awareness related to SPS. As a result of the practices, it was ensured that pre-service teachers learn by doing. The results of this were positive. The increase of SPS used in lessons is an indicator of this. In addition, as the pre-service teachers' knowledge level increased, their self-confidence improved, and their control over the course also increased. It was noticed at the end of the second lesson that they easily integrated the skills they did not use before or even were aware of. The research conducted by Lanka (2007) showed that school laboratory experiences helped students to reveal important aspects of science and at the same time to develop knowledge about certain science concepts. Thus, science teachers had the necessary knowledge and skills to plan and carry out learning experiences that expose students to research experience. The research emphasized the relevance of SPS development to academic ability. In this respect, the skills learned through practice provide a better transfer to students.

Many pre-service teachers did not use many of the SPS in their first lesson. The SPS used were limited and they only transferred 4 of them to their courses, knowingly or unknowingly. In the second lesson, it is seen that they can integrate 8 SPS into their lessons. pre-service teachers could not use all SPS. Besides, the subject and content of the lessons described are not comprehensive enough to convey all SPS.

In the second lessons, it was seen that pre-service teachers have more confidence and try to address almost every science process skill. The reason for this is that they become aware of the mistakes they make through the increase in knowledge levels and feedbacks. It seems that science teaching practices are linked to motivation (motivational beliefs, constructivist activities and development of SPS). Therefore, if pre-service teachers have positive attitudes towards practical activities, this may significantly affect their performance (Ornstein, 2006). Therefore, the fact that teachers mastered SPS enabled them to transfer these skills to their students in a better way.

Prospective primary school teachers play an important role in laying the foundations of SPS. To fully fulfil these roles, they need to have a comprehensive knowledge of SPS and use these skills effectively (Yıldırım & Sezek, 2014). Also, it was found that teacher competence in SPS encourages a positive attitude towards science among students (Luft, 2001). Molefe, Stears and Hobden (2016) stated in their study that the statements explaining which SPS are included in which activity, how these SPS can be acquired, what each skill means and how they can gain competence in this skill will contribute to a better understanding by students. As a result, it can be said that SPS serve as a very important way for pre-service teachers to start learning science teaching. Therefore, pre-service teachers should have a strong conceptual understanding and be able to effectively fulfil their SPS in their classrooms.

Sukiniarti (2016) stated that teachers should have some competencies in order to transfer the SPS. These are the teacher paying attention to the student's characteristics and finding the right time in applying the science process skill approach; to guide students during the research and to make them active in learning, they must always motivate the student and be able to strengthen their pedagogical knowledge, including science pedagogy, especially for primary school students. In this regard, it should be ensured that the pre-service teachers have these competencies. For this, lessons can be designed so that pre-service teachers can gain comprehensive knowledge of SPS and get to practice during the lesson. Additionally, pre-service teachers can be encouraged to use SPS in teaching practice lessons.

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