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The Analysis of Science Process Skills on Pre-Service Elementary School Teachers

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Abstract

This research aimed to figure out how Science Process Skills (SPS) of pre-service elementary school teachers from elementary to high schools are and to analyze the need to develop these skills in the lecturing program. The method of this research was quantitative research with survey design. The participants in this study were 85 pre-service teachers of early semester students of Elementary School Teacher Education Program. 31 pre-service teachers have science education backgrounds, while 54 pre-service teachers do not have them. The research data were obtained from the test instruments given to the participants, and the responses were later analyzed and classified. Research result shows that the SPS of pre-service teachers are inadequate on the indicators tested including: planning experiments, hypothesizing, communicating, and concluding. There is no difference between participants who are from the science background and those who are not. Hence, pre-service teachers need to start developing and improving their SPS in the lecture process in order for them to provide the most optimal science teaching.

Keywords: *science process skills, pre-service elementary pre-service teachers, science lesson.*

Abstrak

Penelitian ini bertujuan untuk mengetahui bagaimana Keterampilan Proses Sains (KPS) dari calon guru sekolah dasar mulai dari sekolah dasar sampai dengan sekolah menengah dan menganalisis kebutuhan untuk mengembangkan keterampilan ini dalam program perkuliahan. Penelitian ini menggunakan metode kuantitatif dengan desain survei. Partisipan dalam penelitian ini berjumlah 85 orang calon guru pada Program Pendidikan Guru Sekolah Dasar pada semester awal. 31 calon guru memiliki latar belakang sains dan 54 calon guru bukan berlatar belakang sains. Data penelitian didapatkan dari instrumen tes yang diberikan pada partisipan kemudian jawabannya dianalisis dan diklasifikasikan. Hasil penelitian menunjukkan bahwa KPS calon guru tidak memadai pada indikator yang diujikan yaitu: merencanakan percobaan, berhipotesis, berkomunikasi, dan menyimpulkan. Tidak ada perbedaan antara partisipan yang berasal dari latar belakang sains atau tidak. Oleh karena itu, calon guru perlu mulai mengembangkan dan meningkatkan KPS mereka dalam proses perkuliahan untuk memberikan pengajaran sains yang paling optimal.

Kata kunci: *keterampilan proses sains, calon guru SD, pembelajaran sains*

INTRODUCTION

Educational policies in various developed countries assume that one of the main goals of education is scientific literacy in their country's educational process. For instance, several member countries of the European Union and the United States suggested that citizens' literacy on science needs to be improved in order to understand the challenges of science, society, and interaction among them in the future (Kampourakis, 2016). Therefore, science education's main goal should be to educate future citizens who will be literate on science.

Scientific literacy has an important role in everyday life. The advancement of scientific literacy has been recognized as the main goal of science education (Kampourakis, 2016). Educators and researchers agree that scientific literacy should be developed as early as possible (Turiman, Omar, Daud, & Osman, 2012). It is in line with the aim of science education nowadays which is to educate individuals to be able to adapt to different conditions, to think flexibly, to ask questions actively, to be creative, to think critically, to solve problems, and to respect other people's opinion (Aktamiş & Yenice, 2010; Ratnasari, Sukarmin, Suparmi, & Harjunowibowo, 2018).

The goal of science education is always changing, and there are currently eight main things about that goal. Those are: 1) science process skills, including asking questions or problems, doing observations, collecting and classifying the data, designing the experiments, hypothesizing, constructing the theories and models, and comparing ideas and alternative modes; 2) purposes and values, including make predictions and providing some explanation, high confirmation, consistency, testability, correctness, and simplicity; 3) methodologies and rules including constructing a highly testable hypothesis/ theory/ model, choosing a more reasonable theory, rejecting inconsistent ideas or views; 4) knowledge, including laws/ ideas/ theories/ models, observational reports or experimental data; 5) professional activities, including attending academic meetings, presenting and publishing findings; 6) scientific ethe, including integrity, openness, respect for the environment, and freedom; 7) social dissemination on the scientific knowledge, like peer review or discussion; and 8) the social values about the science, including respect, freedom, and social utility (Irzik & Nola, 2014; Irzik & Nola, 2011; Kampourakis, 2016). Therefore, the science education process must always develop following the life skills needed in the future.

One of the main things of the eight science goals is the development of Science Process Skills (SPS). SPS are particular skills to simplify science teaching and learning, make students more active, develop students' sensitivity on understanding, and make concepts remain in their minds by teaching using scientific methods (Gunawan, Harjono, Hermansyah,

& Herayanti, 2019; Ratnasari et al., 2018; Roesch, Nerb, & Riess, 2015). Furthermore, Öztürk, Tezel, & Acat (2010) and Turiman et al (2012) state that the SPS are a set of procedures performed by scientists to carry out investigations to develop knowledge. Advanced training on SPS for students and students' SPS development will be beneficial for them to build their knowledge and learning and their resources in their daily lives.

SPS are also parts of the thinking skills used by researchers, scientists, teachers, and students when thinking or studying science. SPS can be useful skills in science lessons and science activities, including investigation and interpretation (Turiman et al., 2012). SPS can be developed by understanding learning to guide students to connect new and previous experiences and concepts. Science learning with understanding learning enables them to describe concepts/ theories, make predictions, ask questions, test predictions, and interpret data. Besides, science lessons can develop three aspects that students must have. Those are cognitive skills (minds-on), psychomotor skills (hands-on), and social skills (hearts on) (Savitri, Wusqo, Ardhi, & Putra, 2017; Supahar, Dadan, Ramadani, & Dewi, 2017).

Based on the explanation, the science learning process needs to develop students' SPS from early ages, which include observing, classifying, communicating, measuring, predicting, planning experimenting, hypothesizing, interpreting data, and concluding (Akinbobola & Afolabi, 2010; Duruk, Akgün, Dogan, & Gülsuyu, 2017). These skills are the most meaningful outcomes of the correct interpretation of events and educational programs used in every scientific study stage, such as in biology, physics, and chemistry. However, before students develop these skills, firstly teachers must possess these skills themselves to optimize the development of their students' SPS.

The research conducted by Akani (2015) indicated that pre-service teachers have adequate levels of experimentation, observation, and measurement skills, and they have low inference and communication skills. Based on the results, it is recommended that the lecturing process should emphasize more on these skills. Furthermore, (Laçin-Şimşek, 2010) found that the pre-service teachers had problems with determining the SPS such as hypothesizing, planning experiments, making models, and using the data. Therefore, it is necessary to analyze how pre-service teachers' SPS in Indonesia, especially in elementary school teachers are. Many studies show that the SPS of Indonesian students are remarkably low (Prayitno, Corebima, Susilo, Zubaidah, & Ramli, 2017). One of the reasons is the teacher's inadequate ability to provide a learning process developing SPS. The teacher may have never faced anything related to SPS either during school or during the lecturing process. This study analyzed how the pre-service teachers' SPS from elementary to high schools and this study can reinforce the need for the development of SPS in lecturing programs.

METHODS

The quantitative method with a survey design was used in this research. The purpose of this research was to get a description of how the pre-service teachers' science process skills were while they studied at formal school levels from elementary to high school and also to analyze the needs for developing SPS in the lecturing program. Participants in this study consisted of 85 early semester pre-service teachers of Elementary School Teacher Education study program in Sumedang Indonesia. The participants comprised of two educational backgrounds in which 31 participants had science education backgrounds and 54 participants did not have science education backgrounds.

The research instrument used in this study was an instrument developed by Kazeni (2008) consisting of four main indicators of SPS. These are planning experiments, hypothesizing, communicating, and concluding. The instrument was in the form of a multiple-choice test with four answer choices with the total number of 30 questions. Each main indicator consisted of sub-indicators, including 1) planning experiments: determining the dependent, independent, and controlled variables; determining what is measured, observed, and recorded; and determining the design for an investigation; 2) hypothesizing: the ability to determine a hypothesis; 3) communicating: obtained results/data, and investigation; graph identification based on data; and 4) concluding: making a conclusion.

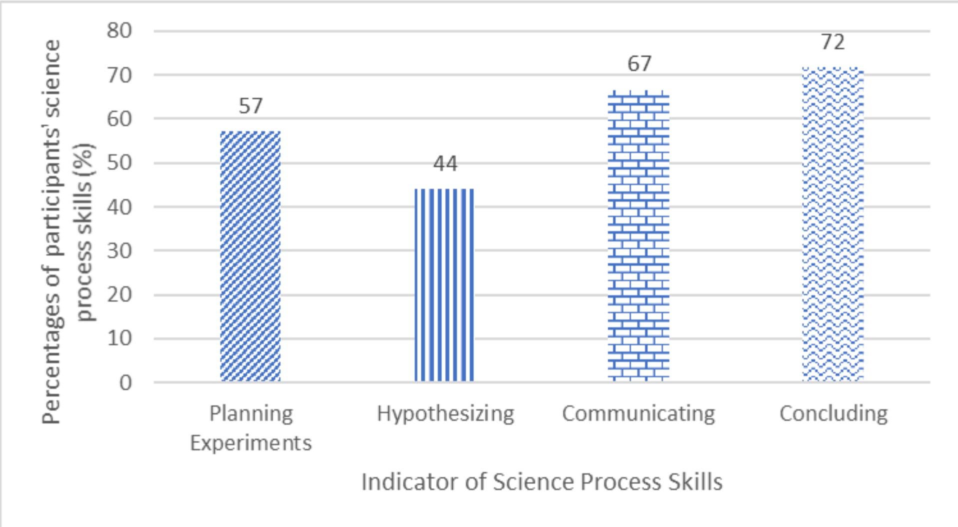
The study was conducted by giving the instrument to participants and later analyzing their test results based on the SPS indicators. Then, to get more detailed data and to confirm the results obtained, after the participants were given a test, the researcher gave questions about the SPS instrument, which contained four main issues: 1) whether the participants ever faced this instrument before, 2) how they felt after working on the instrument, 3) whether this instrument was more complicated that ordinary tests and 4) whether these skills were needed to be developed in elementary students. These questions are useful to get an idea of their opinion about the type of SPS instrument.

In this study, participants were given two scores, namely 0 score if they gave the wrong answer and 1 score if they gave the correct answer. The mean scores of participant test results were calculated and converted to percentages. Then, the percentage results were classified into categories made by researchers and researchers modified the interpretation developed by Malik (2015). The participants' responses were divided into two main statements marked with 0 score if they did not agree and 1 score if they agreed with the statements. The ranges interpretation and categories of the participants' SPS responses were divided into five categories, namely Very Good (80-100), Good (70-79), Fair (60-69), Poor (40-59), Very Poor (30-39).

RESULTS AND DISCUSSION

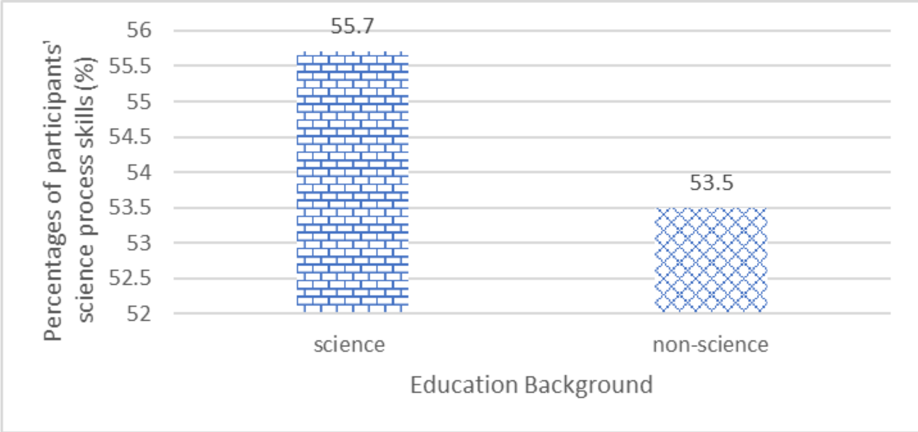
Science Process Skills of Pre-Service Teachers

The results of this study will be discussed starting from pre-service teachers' science process skills (SPS) based on the indicators tested, then looking at how the differences are obtained between students with a science education background and those that are not. Then, how they responded to these types of instruments were observed. The analysis of participants' SPS on each indicator can be seen in Graph 1.



Graph 1. The Analysis of Participants' SPS

Based on Graph 1, it can be seen that of the four SPS indicators, the highest percentage is 72% on Concluding which belongs to Good category. The question given in the instrument about this indicator was whether participants able to derive the conclusion of an experiment. Meanwhile, the Communicating indicator is divided into two parts, namely obtained results/data and investigation and graph identification based on data. It belongs to Fair category with the percentage of 67%. The indicator of Planning an experiment is in Poor category, which is 57%. The sub-indicators of this skill show that only the indicator of determining the variables is in the Poor category, while the others are in Very Poor category. The lowest indicator of the four SPS indicators is the Hypothesizing skill that is in Poor category. Then, graph 2 will show the differences between participants with science education backgrounds and those that are not.



Graph 2. Analysis of Participants' SPS Based on the Educational Background

Graph 2 shows that there is a slightly different percentage between participants with the science educational background and those without it, although the average percentage of the former is higher. This indicates that SPS have not become the concerns in the science learning process from elementary to high schools. It can be seen that both participants groups are in the Poor category in this skill. This phenomenon is undoubtedly different from one of the goals of science education, which is to make the process as one of the main objectives that must be developed in the learning process.

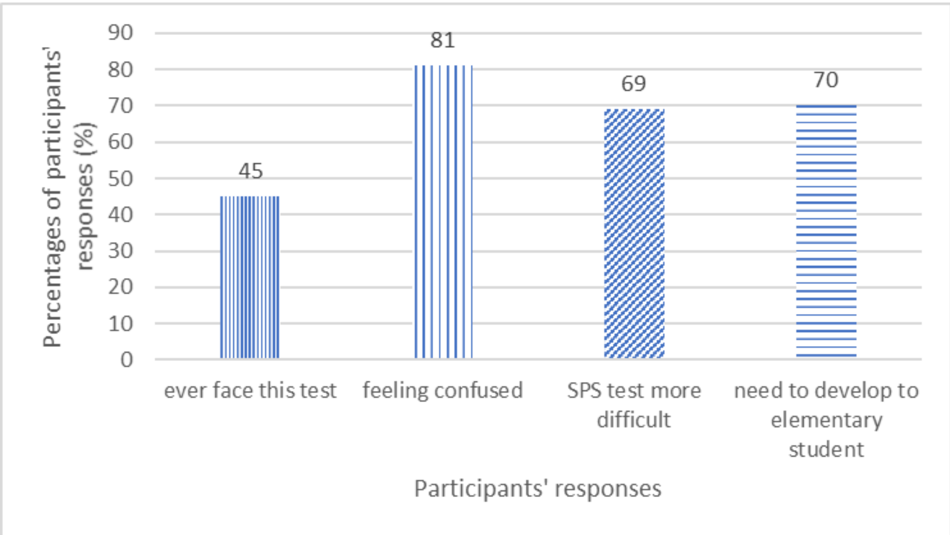
The results of this study indicate a similarity with Laçin-Şimşek (2010). This research shows that elementary pre-service teachers have problems in determining the SPS, such as hypothesizing and planning experiments. Besides, the research conducted by Akani (2015) suggests that in-service and pre-service teachers must develop these skills for themselves and their students. SPS also become curriculum goals used in Indonesia. The curriculum states that the learning process must be student-centered because it can make learners become actively construct principles, concepts, theories, and laws through the stages of observing, formulating problems, hypothesizing, collecting and analyzing data, concluding, and communicating the concepts, laws, or principles obtained (Kemendikbud, 2013).

The research results also reveal no significant difference between participants with science educational backgrounds and those that are not. These results indicate that the skills have not become concerns in science learning in schools. They did learn science for 9-12 years, starting from elementary to the high school levels, but the results obtained were not in line with expectations. This research proves that SPS are skills that need more attention in the science learning process at every educational level.

In the science learning process, the teacher must be able to develop and understand these skills, so the students can acquire the skills needed (Mutisya, Rotich, & Rotich, 2013). However, most teachers in elementary school generally do not have adequate conceptual understanding about the SPS. Therefore, these skills must be developed through "pre-" and "in-" service training that focus on conceptual abilities and understanding of SPS (Aydoğdu, Erkol, & Erten, 2014; Chabalengula, Mumba, & Mbewe, 2012).

Science Process Skills Needed to be Developed at the Lecturing Program

Science and science learning are integral parts that equip students with scientific knowledge and deal with gaining experience. The process is related to activity, thinking, and being scientific (Malik, 2015; Tawil & Liliasari, 2014). On the other hand, doing science requires students to acquire more complex skills than studying science. Of course, teachers need to facilitate their capacity and use their experiences in daily life (Akgün, Tokur, & Duruk, 2016; Berland & Mcneill, 2012; Duruk et al., 2017). Then, how participants' responses regarding the type of SPS instrument can be seen in Graph 3.



Graph 3. The Analysis of Participant's Responses

Graph 3 shows the participants' responses regarding the type of SPS instrument that has been given. The results of these responses indicate that only 45% of participants have faced this type of instrument, and most of them have never faced it. This is the reason why the percentages of participants both those with the science education background and those that are not belong to Poor category. Also, most of them (81%) were confused to answer the instrument because they were accustomed to deal with questions based on concepts/ memorization. When they encountered the SPS instrument, it is very different because it is free from concepts and emphasizes on their logical thinking about the process in science lessons.

Participants' responses also show that the majority of them (69%) think that this type of instrument is more complicated than the usual kind of instrument faced. On the other hand, most of them (70%) also assume that skills like these need to be developed starting from elementary school. They believe that these skills can facilitate students to think logically, systematically and scientifically.

This study also shows that most participants have never faced the SPS types of questions and they find them confusing and difficult. The big question is whether the students have never experienced the experimental process during the learning process. If the experimental activities are carried out well, the participants' SPS will be even better. Therefore, SPS should be developed by students starting from early ages. SPS have crucial roles in solving various problems. Aydoğdu, Erkol, & Erten, (2014) assume that SPS and content knowledge complement each other. Teachers and pre-service teachers must have the knowledge, understanding, and materials needed to teach SPS (Chabalengula et al., 2012).

SPS could be thought of as moderators in activating students in conducting investigations about scientific phenomena that can improve student achievement (Aziz & Zain, 2010). Recent research has shown that there is a significant positive correlation between SPS and students' academic achievement (Delen & Kesercioğlu, 2012). In addition, both are interrelated with conceptual change processes. Hence, to develop high-level conceptions of students SPS cannot be separated from conceptual change and conceptual understanding (Karamustafaoğlu, 2011). Although these skills are important parts of the students' learning process from elementary to high school levels, it is found that generally students do not have adequate SPS included in the science curriculum (Delen & Kesercioğlu, 2012).

In general, the participants argued that pre-service elementary teachers must develop SPS in science learning. However, it is proven that the science learning process that participants got was less than optimal. Several studies that have been mentioned demand the need to develop these skills for teachers and pre-service teachers in the science learning process. Teachers who have good SPS can undoubtedly develop their students' SPS. Also, we use the thinking skills to obtain information, think about problems, and formulate results. They are also skills scientists use in their studies (Aydoğdu, 2015; Karamustafaoğlu, 2011; Mutlu & Temiz, 2013). Individuals who cannot use SPS will have difficulties to succeed in everyday life because SPS development allows students to acquire the skills necessary to solve everyday problems (Aydoğdu, 2015; Aydoğdu et al., 2014).

Teachers are expected to impart these science process skills to students, hence the teacher's conceptual understanding of these skills is very important. Science material taught in science class should be used as a means to develop SPS (Mutisya et al., 2013). Pre-service elementary teachers should be equipped with basic SPS to facilitate the development of these skills towards an integrated level. Ensuring that students improve their research, inquiry, and critical thinking skills and become lifelong learners is a priority among science teaching goals. According to SPS, they are significant in the process of training students who have these characteristics. SPS is considered as a defining and inseparable part of science education (Duruk et al., 2017). In essence, SPS are thinking skills that scientists use to construct knowledge, to solve and evaluate problems and to formulate results. Also, students using the skills they have to organize scientific information, to allow them to process new information through real-life experiences, and to help them understand the nature of science (Akgün et al., 2016; Duruk et al., 2017; Farsakoglu, Sahin, & Karsli, 2012).

CONCLUSION

Based on the findings of the study, it can be concluded that pre-service teachers' SPS need to be developed and improved because of the four main indicators, only Concluding skills are categorized as Good. While, the Communicating skills is in the Fair category. Both skills are the basic level of SPS. However, at the integrated level, the Planning experiments and Hypothesizing indicators are both in the Poor category. There is no significant difference between participants' backgrounds in science education and those that are not, and this indicates that SPS are important skills. On the other hand, these have not been considered in the science learning process. The teacher has a crucial role in the process of science learning to develop student SPS. One of the best ways to develop these skills is teachers must comprehensively understand SPS. Science content taught in science should be used to develop SPS. Because SPS are essential skills for pre-service teachers, this study suggests that these skills should begin to be developed and improved in the lecturing process to provide the most optimal science learning process.

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