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IMPLEMENTATION OF SAINTIFIC APPROACH BASED ON STEM EDUCATION TO INCREASE SCIENTIFIC LITERACY

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Abstract

This study aims to determine the effectiveness of the saintific approach based on STEM education to improve scientific literacy. This research was conducted with an experimental method in which the sample consisted of one experimental class that received a treatment, namely given learning with a scientific approach based on STEM (Science, Technology, Engineering, and Mathematics) education and one control class given learning with a scientific approach, then in the end of learning is analyzed its effectiveness by calculating the magnitude of the increase (N-Gain) of scientific literacy, as well as the responses of prospective teacher students at Universitas PGRI Semarang to the learning process that has been carried out. It was concluded that the saintific approach based on STEM education was effective in increasing the scientific literacy of elementary school teacher candidates. The average value of N-gain for the the experimental class was obtained 0.61 in the high category and the control class was 0.34 in the medium category. The learning processes applied saintific approach based on STEM education get very good response, especially in an effort to improve scientific literacy of elementary school teacher candidates.

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INTRODUCTION

The 21st century is marked by the development of science and technology, especially in the fast and easy field of Information and Communication Technology (ICT). Because of the sophistication of this ICT technology a variety of information can be accessed quickly and easily by anyone and from anywhere. The rate of development of ICT that is so massive resulting in a variety of sophisticated technology software innovations has greatly impacted the lives of the people in various fields including education at all levels. The era of disruption and ICT began to change the pattern of implementation of education, the standard arrangement of employment, and the structure of interaction between people. This implies that education is faced with increasingly severe challenges, one of which is that education should be able to produce human resources who have the full ability to face various challenges in life, especially in the era of disruption and the new world of the industrial revolution 4.

In essence, education aims to equip individuals to carry out their lives wisely. Through education each individual is expected to have a set of knowledge, skills, life skills (life skills), and the values needed to develop into a full human being and can contribute to the state, society or at least for themselves (Rahayu, 2016). Education in Indonesia does not appear to have succeeded in creating reliable human resources, moreover to the extent of improving the quality of the nation. Some benchmarks that show the low quality of education in Indonesia are ranked in the Human Development Index (HDI), TIMSS, PIRLS and PISA. The last three assessments illustrate the low mathematical literacy, reading literacy and scientific literacy of Indonesian students.

The teacher is the forefront of education practitioners who are responsible for student literacy. LPTK as a teacher printing institution can improve the professionalism of prospective teachers professionally through the creation of teaching and learning processes that explicitly lead to the development of students' scientific literacy. The rapid development of science and technology, plus the implementation of curriculum refinements that have not been comprehensively understood by education practitioners are thought to have contributed to the lack of insight into scientific thinking and developing scientific work skills (Rustaman, 2016). Science learning that emphasizes remembering concepts only, in a way that does not equip learning throughout the future and oriented towards the future also aggravate these conditions.

Education Prospective teachers in university must be able to prepare graduates to be ready and reliable in entering the workforce according to specified requirements. To deal with changes very quickly, the learning process, especially science education should be guided by the principles of a scientific approach (Taufiq & Wijayanti, 2014). This approach is characterized by highlighting the dimensions of observation, reasoning, discovery, validation, and explanation of a truth. Thus, the learning process must be carried out guided by values, principles, and criteria of qualified scientific work skills.

Science literacy is a very important competency to master for the success of elementary school teacher candidates, especially in learning science. This is also in accordance with the mandate of the curriculum which states that Learning Achievement (CP) of S1 graduate students prospective elementary school teachers include having qualified scientific literacy, having the ability to think and act creatively, think and work scientifically, productively, critically, independently, collaboratively, and communicative. It can be seen that the aspect of scientific literacy is one of the main and important things that needs to be instilled in prospective elementary school teachers.

Science literacy focuses on building students 'knowledge and using science concepts meaningfully, thinking critically and making balanced and adequate decisions on issues that have relevance to students' lives. Although the term scientific literacy has been used in literature for the past four decades, the notions expressed here are not always the same. Gräber et al. (2001), describe literacy more fully to bridge various understandings of scientific literacy in the literature.

One effort that can be implemented is to provide a treatment that can bring students to literate science or scientific literacy by applying STEM (Science, Technology, Engineering, and Mathematics) Education, namely scientific approach learning by integrating STEM fields including science, technology, engineering, and

mathematics (Rustaman, 2016; Permanasari, 2016; Afriana et al., 2016; Ismayani, 2016; Ismail et al., 2016). Daugherty (2013) said that in STEAM education the ultimate goal of learning is the result of cognitive activities (cognitive outcomes) in learning, which contain learning content that is expected to be known.

In the context of primary and secondary education, STEM education aims to develop learners who are STEM literates (Bybee, 2013) with the following details. STEM education gives educators the opportunity to show students how concepts, principles and techniques from science, technology, engineering, and mathematics are used in an integrated manner in the development of products, processes and systems used in their daily lives. Therefore, the definition of STEM education was adopted as an interdisciplinary approach to teach (Reeve, 2013). In STEM-based learning students use science, technology, engineering, and mathematics in real contexts that connect between school, the world of work, and the global world, in order to develop STEM literacy that enables students to be able to compete in a new era of knowledge-based economy (Rustaman, 2016).

One of the characteristics of STEM Education is integrating science, technology, engineering and mathematics in solving real problems. However, there are various ways used in practice to integrate STEM disciplines, and the pattern and degree of cohesiveness depend on many factors (Roberts, 2012). It can also be done to teach each STEM discipline by focusing more on one or two of the STEM disciplines. The third way is to integrate one into three STEM disciplines, for example engineering content is integrated into science, technology, and mathematics subjects. A more comprehensive way is to blend the four STEM disciplines and teach them as integrated subjects, such as technological, engineering and mathematical content in science, so that science teachers integrate T, E, and M into S.

Starting from the problems that have been described, in an effort to improve the scientific literacy of prospective elementary school teacher students need to be taken steps to improve the quality of lectures that equip science material through learning with scientific approaches based on STEM education. This study aims to provide meaningful activities with a scientific approach that is demonstrated through observation, grouping (classification), communication and interpretation, asking questions, and planning an experiment by implementing a scientific approach based on STEM Education to increase scientific literacy of elementary school teacher's candidates.

METHODS

The research conducted was a quasi-experimental research with one group pretest-posttest design. The population in this study were odd semester students in the 2018/2019 academic year PGSD study program at the Universitas PGRI Semarang who took science education courses in elementary school prgram, with the research sample being selected from one experimental and control class using purposive sampling technique, namely the technique of taking source samples data with consideration of data with certain considerations (Sugiyono, 2011).

This research was designed with an experimental method in which the sample consisted of one experimental class that received a treatment, namely given learning with a scientific approach based on STEM (Science, Technology, Engineering, and Mathematics) education and one control class given learning with a scientific approach, then in the end of learning is analyzed its effectiveness by calculating the magnitude of the increase (N-Gain) of scientific literacy, as well as the responses of prospective teacher students at Universitas PGRI Semarang to the ongoing learning process.

The preliminary research phase is carried out to prepare and design the research instrument. After that, applying scientific approach based on STEM (Science, Technology, Engineering, and Mathematics) education. Furthermore, at the end of the study the effectiveness analysis is done by analyzing the increase (N-Gain) of scientific literacy, as well as the responses of prospective teacher students at Universitas PGRI Semarang to the ongoing learning process.

The data includes the results of the pretest-posttest and questionnaire sheets. The instrument includes a reasoned multiple-choice test item to measure scientific literacy and questionnaire sheets to get student responses to the learning implementation. Data from the test results were analyzed by calculating the

normalized gain (N-Gain) based on the N-Gain Hake formula (2007). The results of the student response questionnaire data were analyzed in the format of learning outcomes using the categories proposed by Riduwan (2012).

RESULTS AND DISCUSSION

This research was conducted four times including pretest and posttest. Pretest is done to find out whether there are differences in the initial ability of experimental class students and control class students by giving 10 literacy science questions for the content and competency domains, while the attitude domain is 5 questions. After being given a pretest, learning is carried out using the STEM-based scientific approach three times in the experimental class and learning with the scientific approach in the control class. Posttest is given after learning to find out the level of scientific literacy achievement.

The results of the analysis of science literacy ability test scores showed that the average scientific literacy ability of students who were treated with STEM-based scientific approach was 85.33. While the average value of the test of literacy ability of students who obtain learning treatment with a scientific approach is 74.67. The ability of the experimental class and control class students on the three competencies of scientific literacy ability to explain scientific phenomena, evaluate and design scientific investigations and interpret data and scientific evidence is presented in Figure 1.

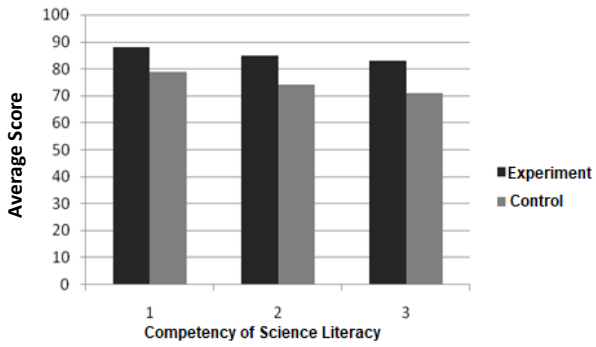

Figure 1. The ability of experimental class and control class students on all three competencies in scientific literacy abilities

Information: (1) explains scientific phenomena; (2) evaluating and designing scientific investigations; (3) interpret data and scientific evidence.

The effectiveness of the STEM-based scientific approach in this study can be seen from the increase in student scientific literacy, where the STEM-based scientific approach can be implemented in learning when there is an increase in student scientific literacy. Increased scientific literacy is analyzed from the average value of the three scientific literacy competencies including: (1) explaining scientific phenomena; (2) evaluating and designing scientific investigations; (3) interpret data and scientific evidence.

The results of the analysis of the pretest, posttest and gain (increase) scores of students' scientific literacy are presented in the following Table 1.

Table 1. Increasing Science Literacy of Prospective Elementary Teacher Students

Average Score	Experiment Class	Control Class
Pre test	62,33	61,67
Post test	85,33	74,67
N-gain	0,61	0,34

Based on data both in Figure 1 and Table 1 gives an illustration that the average pretest and posttest scores of experimental and control class students were 85.33 and 74.67, respectively. While the average value of the pretest experimental and control classes are 62.23 and 61.67, respectively. Increased student scientific literacy can be demonstrated through the N-Gain of the average value of student scientific literacy. The N-gain of the average value of the experimental class obtained was 0.61 in the high category and the control class was 0.34 in the medium category. This result is also supported by several previous studies, namely Hastia (2012) and Anwar (2012)) the results of his research stated learning with a scientific approach can increase student scientific literacy.

The increasment results obtained in the experimental class in general can be explained that the application of the STEM Education-based scientific approach in lectures / learning can encourage students to design, develop and utilize technology, sharpen cognitive, manipulative and affective, and apply knowledge. Therefore, the application of STEM is suitable for use in science learning. Learning with a scientific approach based on STEM Education can train students in applying their knowledge to create designs as a form of

problem solving related to the environment by utilizing technology.

Learning with a STEM Education-based scientific approach has given students the opportunity to apply knowledge to issues/ problems as a form of problem solving. Indirectly, the use of a scientific approach based on STEM Education also encourages students to master the knowledge needed to solve these problems. This knowledge can be in the form of information or data which is then used as material for consideration to choose the right solution for the problem through logical, critical, and systematic thinking. Parwati's research results in the context of the environment show that STEM learning can build creativity and environmental literacy, which is very necessary to face the 21st century (Parwati et al., 2015).

The STEM Education-based scientific approach also guides students to solve the given problems and places more emphasis on the products produced (Sanabria & Arámburo-Lizárraga, 2017); Thibaut et al., 2018). The resulting product can be ideas or even devices that can be seen. Products that are produced from the use of STEM Education-based scientific approaches in science learning can be a student's contribution to improving the quality of life. In making this product, students can take advantage of science and technology related to everyday life implemented in experiments designed during lectures so that students indirectly understand the functions and benefits of science and technology itself for the benefit of the environment. Solving problems in life and making products are done individually or in groups. Work in groups can encourage students to work together but remain responsible for their work independently. In addition, as a group students can manage their learning independently in accordance with the conditions of their respective groups.

STEM education that has been formatted based on a combination of several scientific disciplines into one form of unity with a scientific approach. The scientific disciplines that are a component of the STEM approach are science, technology, engineering and mathematics. The integration of several of these disciplines in a single unit is expected to be able to produce competent and qualified graduates not only in terms of mastery of concepts but also in applying them to life (Bhakti et al., 2020).

The integration of the STEM-based scientific approach helps students in analyzing and solving problems that occur in real life so students are ready to work. Knowledge used in solving these problems is the definition of scientific literacy. Science literacy becomes individual scientific knowledge and the use of that knowledge to identify questions, to gain new knowledge, to explain scientific phenomena, and to draw conclusions based on facts that students encounter in their daily lives.

In general, student responses to the learning process with a scientific approach based on STEM Education in the category strongly agree with a percentage of more than 84%. The average percentage of students who responded strongly agreed to 90.25%. The percentage of responses "strongly agree" to the statement "Learning accommodates students to carry out communicating activities" that is equal to 95%, while the lowest percentage of responses strongly agrees to the statement "Student-centered learning" and "Learning accommodates an increase in scientific literacy capabilities including (1) explaining the phenomenon scientific; (2) evaluating and designing scientific investigations; (3) interpret data and scientific evidence "that is equal to 84%.

Based on the results of the analysis of student response data obtained it can be concluded that lectures or learning processes with a scientific approach based on STEM Education have been going very well, especially in an effort to improve scientific literacy of elementary school teacher candidates. In applying the Scientific Approach, the lecturer has an understanding and creativity in delivering the material with the scientific approach. The understanding and creativity of lecturers in applying the Scientific Approach can be seen in terms of understanding the application of the approach when implementing learning. The application of a scientific approach to learning has involved skills in processes such as observing, and classifying, measuring, not forgetting to predict, explain, and conclude. In carrying out these processes, teacher/ lecturer assistance is needed. However, the teacher/ lecturer assistance is increasingly reduced in the learning process, with increase of students learning maturity (Sumayasa, 2015, Sinambela, 2013).

CONCLUSION

Implementation of saintific approach based on STEM Education is effective to increase scientific literacy of prospective elementary teacher students. The N-gain of the average value of the experimental class obtained was 0.61 in the high category and the control

class was 0.34 in the medium category. Lectures or learning processes with a scientific approach based on STEM Education get very good response, especially in an effort to improve scientific literacy of elementary school teacher candidates.

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