Projects for the implementation of science technology society approach in basic concept of natural science course as application of optical and electrical instruments’ material

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Abstract. Preservice teachers in primary education should be well equipped to meet the challenges of teaching primary science effectively in 21century. The purpose of this research was to describe the projects for the implementation of Science-Technology-Society (STS) approach in Basic Concept of Natural Science course as application of optical and electrical instruments’ material by the preservice teachers in Elementary Schools Teacher Education Program. One of the reasons is the lack of preservice teachers’ ability in making projects for application of STS approach and optical and electrical instruments’ material in Basic Concept of Natural Science course. This research applied descriptive method. The instrument of the research was the researcher himself. The data were gathered through observation and documentation. Based on the results of the research, it was figured out that preservice teachers, in groups, were creatively and successful to make the projects of optical and electrical instruments assigned such as projector and doorbell. It was suggested that the construction of the instruments should be better (fixed and strong structure) and more attractive for both instruments, and used strong light source, high quality images, and it could use speaker box for projector, power battery, and heat sink for electrical instruments.

1. Introduction

Science knowledge, in all its applications, permits humans to solve the problems of environment in which they exist. The knowledge of sciences is the most worth in education. The productivity value of scientific knowledge refers that the knowledge has the ability to promote productivity progress, such as “science and technology is the first productivity”, that means the scientific knowledge and technical knowledge are productive value knowledge. Scientific knowledge, as a form of knowledge, combined with other forms of knowledge, can help people better understand the world and transform the world [1]. Science in practice rests on: 1) The world of observable phenomena is real and intelligible in a collective manner, 2) This public knowledge is subject to the requirements of logic and consistency, 3) In addition to logic the knowledge must be based on observation and experimentation, 4) Science is based on naturalism, by which we mean methodological naturalism [2]. Scientific concepts, theories and laws put forward by scientists have an impact on the invention of technology. The development of science impacts the creation of technological progress. Technology is the part of applied science that
transforms the understandings and discoveries of science into applications for society [3]. Technology was born by the needs of society. Society is a large group of people who live together in an organized way, making decisions about how to do things and sharing the work that needs to be done. Society is the sphere of institutions, organizations and individuals located between the family, the state and the market, in which people voluntarily associate to advance common interests [4].

The advancement of science and technology are dedicated not only to facilitate the quality of human life, but also to educate human beings themselves with values to be high quality beings and more humble people to God. The development of science and technology basically aim to further simplify all activities performed by humans [5]. The development of science and technology lately is highly astonishing and generates several changes affecting almost every aspect of human life. Such development has also changed the cultural value, behaviors and habits of people in doing interaction with others. It has connected and facilitated people to do their jobs and to deal with their life. It’s also aim to improve the efficiency of doing our activities.

One of the rapid developments in science and technology for society occurs in the field of communication; phones, computers, and internet which has diminished the physical barriers among people to communicate and has allowed them to interact freely on a global scale easily, cheaply and fast. The development of science and technology projects, basically is intended to increase the welfare of human beings and the quality of human life. The development of science and technology projects is also will help to growth of sustainable natural resources-based industries. Increased exports, growing output from industries created by new technologies, despite persistent problems in its important natural resource-based industries. The county’s economy is developing and diversifying away from science and technology production, although remains somewhat concentrated in natural resource-based industries. The role of science and technology research in supporting growth of sustainable natural resource-based industries is the key or very important for nowadays in a country for advancement of science and technology products.

The development and progress in the field of science is highly essential for the advancement of technology. The principles of science are needed for technological development. When science is developed, technology then will also go forward. In order to make Indonesian people move forward and not left behind in science and technology, they must keep pace with the development from the beginning. A growing number of science educators believe teachers should recognize and have their students study the problems solving related to the interface of science, technology, and society need or human existence as early as in the elementary school grades. To achieve this the main objective of the STS course which is required in science teacher education programs is making all students literate about science and technology; the role of science teaching and teachers in achieving this goal is accomplished by encouraging all to understand the interactions of science and technology with each other in society [6]. This notion implies that science must be learned comprehensively by the teacher and children of Indonesia to produce a generation who are awake, alert, expert and skilled, and was not left behind in the application of science and technology. To deal with this expectation, the government has formulated the goals of Natural Science education from Elementary School level. As stated by the Ministry of Education in the curriculum [7] that the learning objectives of Natural Science in primary schools are to develop knowledge and understanding of the concepts of science that are useful and can be applied in everyday life, and to develop curiosity, positive attitude and awareness of the existence of mutual relationship among science, environment, technology and society. Science is one of the subjects in elementary schools that could facilitate the students to develop the knowledge and the concepts of science to create a simple and applicable technology for society. To realize the goals of Natural Science education, knowledge enrichment, improvement and innovation over the learning process in science teacher education program are needed.

Natural Science education in elementary school and elementary school teacher education program has been less "grounded" because a lot of materials seemed to be unrelated to the students’ real life. Consequently, many students felt that learning Natural Science was less meaningful. The natural Science learning process in Elementary School was not able to facilitate the students to develop
technology as if science and technology are not interrelated. To deal with the development of science and technology, the learning process at elementary school teacher education should be adjusted to and must be more innovative to improve the quality of student’ learning. Hence, the Natural Science learning process could keep pace with the advancement of technology and be more meaningful for the students and the society in general. A focus on the relationship among science, technology, and society is considered essential for achieving basic science literacy. Students as the next generation need to be able to analyze evidence, to understand the relevance of science-based issues in their everyday lives, and to understand that scientific endeavors are actually governed by social values [8].

The quality of science and technology learning process is highly dependent on the quality of teaching. The quality and the performance of the teacher always become the factors determining the success of education in Elementary School. If the children of Indonesia want to move forward and be able to keep pace with the developments in science and technology in the 21st century, the quality of Natural Science courses process in Elementary School must be improved and made innovative. In addition, the teachers’ education about science and technology also should be increased. The improvement could be done by applying science and technology in the courses process that can be used for the future development of science learning media. The availability of the media of simple technology is expected to increase the quality and the effectiveness of course process. They would help the teacher in delivering the course materials and enable them to explain the way the principles of science work and the way they are applied in real life. The use of technological media in the course process which has been adjusted to the development of 21st century would motivate and raise the students’ interest in learning. Educational institutions need to prepare either the teachers to be or the official teachers with the knowledge of this need. It is highly dependent on the educational programs offered and the expertise of the lecturers of the institution in Natural Science subject.

The teachers’ lack of knowledge and their low level of education were assumed as the factors generating the low quality of Natural Science learning process and innovation. The teachers never applied the principles of science to design simple and applicable technology. This also was not supported by the availability of the books about application of science and technology in the market.

Based on the researcher’s experience in teaching Elementary School teachers in the Elementary School Teacher Education Program, Faculty of Teacher Training and Education Bung Hatta University Padang since 2010 in Basic Concept of Natural Science course subject and the result of observation done with the preservice teacher doing their final task, it was revealed that the understanding of the Basic Concept of Natural Science by the students was not yet as it was expected. It covered the science conceptual understanding, the application of science in daily life and the use of the principles of science in designing simple projects technology in the learning process. Based on the observation done toward the students while studying Basic Concept of Natural Science course in even semester 2017, it was figured out that less than 1.5/5 of 50 students felt that they have good qualifications in understanding application of science concept to technology especially in optical and electrical instruments’ material. Most of the students felt uncomfortable and had lack of qualifications in making application of science and technology projects in that topics. To be able to apply scientific concepts in simple technology that is useful in elementary school, the quality of the teacher’s education should be enhanced.

Science, technology and society learning should be applied in Elementary School. This was conducted by applying Science-Technology-Society (STS) approach. STS approach is a learning approach that basically discusses the application of science and technology in the context of everyday life. Therefore, the STS approach is also known as an integrated approach between the scientific and technological issues in society. With this approach, the students are required to have willingness and be able to apply the principles of science to produce simple technology as well as offer a solution to reduce the negative impacts that may arise.

STS is also defined as the teaching and learning of science/technology in the context of human experience. STS is to relate science specially to technology and to the society that supports and produces new conceptualizations of both. It focuses on a method of teaching that recognizes the
importance that experience in the real world has on the learning process. And it recognizes that real learning can occur only when the learner is engaged and able to construct her or his own meaning. Science, Technology and Society (STS) is an interdisciplinary field of study that seeks to explore and understand the many ways that modern science and technology shape modern culture, values, and institutions on the one hand, and on the other how modern values shape science and technology [9]. Science, Technology and Society enhances our understanding of the way in which advances in science and technology influence society and vice versa.

Thus, the teachers in teaching science can use STS approach to build the students’ conceptual understanding and to develop the concepts for the benefit of society. Meanwhile, STS education aims to meet the goal of scientific literacy by promoting the teaching and learning of science through the context of the individual in society so that students gain essential science skills and the ability to think critically, make informed decisions, solve problems, work collaboratively, and be technologically efficient [10]. In the STS approach of Yager, it is suggested that the learning process should be conducted constructively. Yager [9] states that there are four phases of the syntax of STS learning model covering invitation phase, exploration phase, explanation and solution phase, and taking action phase.

In this research, the principle of science applied by students to create a simple project was the application of optical and electrical instruments’ material in daily life. Optical instrument is an instrument designed to aid vision. The products made are a projector and a bell. Optical and electrical material was chosen as it was closely related to the advancement of technology in the field of today communication aid. In addition, its application is easily found in everyday life with easily available materials at low cost. So that, the students, by applying science and technology, could design simple communication aid instruments. The project designed could be used as learning media to see how the principles of light properties and series circuit exactly work.

The research from Kok and Van Shoor [11], Negedu, et al [12] and Amirshokoohi [13] indicated that students were able to attain and to retain many skills and competencies defined as science literacy. Such skills and competencies were not developed as a result of study in standard social studies or science courses. Research by Effendi, Rahmiati, Illahi, and Faradisa [14] reported that STS approach can be actively role in learning process and show the role of science and technology in society. Through STS approach students not only understand the concepts and principles, but also the concepts and principles that have been understood and applied in life.

In order to increase the quality of Basic Concept of Natural Science course in Elementary School Teacher Education Program, to make the pre service teachers not left behind and to make the learning process more meaningful and give the students opportunities to apply their knowledge through simple technological projects which can be used as an interesting learning media for the elementary students, conducting descriptive research with projects for application of STS approach was viewed relevant and important.

2. Methods
This research used qualitative research, qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to social or human problems. The process of research involves emerging questions and procedures, collecting data in the participants’ setting; analysis the data inductively, building from particulars to general themes; and making interpretations of the meaning of data. The final written report has a flexible writing structure [15]. This research used ethnography or descriptive method through which the researcher tried to describe projects for implementation of STS approach in Basic Concept of Natural Science course by preservice teachers at Elementary School Teacher Education Program, Faculty of Teacher Training and Education Bung Hatta University Padang in applying the concept of science in optical and electrical instruments’ material. The objects of the research were 50 students; 4 male students and 46 female students in Elementary School Teacher Education Program study program taking Basic Concept of Natural Science course. This research was conducted in one of the classes at Building 2.1.2.5 at Campus II Aia
Pacah University Bung Hatta Padang, West Sumatera on Mei 2017. The research was done in three meetings on Wednesday. The data were collected through observation and documentation. The researcher, in this research, also had a role as the instrument. The data gathered in this research were in the form of qualitative data. The data obtained then were analysed by using descriptive analysis.

The implementation of STS approach in this research can be described as follows. In invitation phase, the researcher encouraged the students to show their initial knowledge about the application of concepts and principles of optic and dynamic electricity in accordance with the materials to be learned. In this phase the researcher asked several questions to the students about the use of optical instrument and electric instrument in their daily life. The students were given opportunities to communicate and illustrate their understanding of the concepts and principles of properties of light and dynamic electricity. Furthermore, the students’ answers were connected to the materials to be taught. Then, the explanation about optical instrument and dynamic electricity and the examples of its application and uses were given such as projector and doorbell.

In exploration phase, the students had chances to do investigation to find the concepts of properties of light and electricity and the use of properties of light and electrical principles through activities of creating project of simple technology whose design had been prepared by the teachers previously. In this phase, they collected the data, practiced scientific process skills and carried out scientific work. Firstly, before the project was made, the students were divided into six groups in which they discussed about designing the simple technology project by applying the principles of science given by the researcher. Each group discussed about the picture, searching and view video of instruments prototype on YouTube including what materials were needed, what kind and where to get it, how to make it or construct it, and how it worked. They also could ask questions about other things they did not understand especially about the picture and video given. The students also asked about the shape or the construction they could possibly make, whether it is acceptable or not. Because of to produce the project took a long time, the students could do it at home and brought it in the next meeting (following weeks).

Furthermore, in the second meeting, explanation and solution phase was done. In this phase, each group of students delivered their explanation regarded to the solution of making the project that had been already done. They explained about the way the instrument worked and how it could work. The researcher would give clarification when they made mistakes in delivering the information. Other groups observing the presentation were allowed to ask questions and responded to what had been delivered and done. The respective group was also asked to submit a summary and a conclusion of a given task. In this phase, the students integrated the solution with the theories found in the books, and build new understanding about the concepts of properties of light and electricity that can be generated by the optical and electrical instruments they had already learned.

The fourth or the last stage of the implementation of STS approach was taking action phase. In this phase, the respective group shared information and ideas, asked follow-up questions regarded to the possibility of further development of the product or instrument, and gave suggestions. They also could share knowledge and skills they acquired to be used in the learning process of Optical Instrument and Electricity in elementary school. Finally, after each group had presented their work, the researcher, as a lecturer, explained other applications of optical instrument and electrical instrument that had been and possibly be made by the experts. This was done to give meaning to the work the groups had already done.

3. Result and discussion
Based on the implementation of STS approach in Basic Concept of Natural Science course in making the projects as application of optical and electrical instruments’ material by applying the concepts of properties of light and electricity, it was revealed that all of the groups were creatively and successful to complete the tasks given. All of the project produced on optical instrument especially projector that used incandescent lamp and flashlight as projector worked appropriately as they were expected. Projector that used magnifying glass and smart phone didn’t result clear, large and bright picture in the
screen. This is can be fixed with additional strong light source, choose or increased the strength of lens of magnifying glass or use a flat mirror after lens in it construction box. The groups could well explain the principles of science that work on the tools or instruments. The only shortage found in these tools was in their construction which is still less attractive and not well-built. In addition, the tools could not use alternate current power for long period because will make the doorbell hot. And more sound can be hear loudly as seeing picture or video if projector can be connected with speaker box.

4. Conclusion
Based on the research findings, it is concluded that projects produced for the application Science-Technology-Society approach in Basic Concept of Natural Science course in PGSD 2 B Class at Elementary School Teacher Education Program has successfully made by the preservice teachers for optical and electrical instruments’ material. The preservice teacher more understood about application of the concept of light and electricity properties and the use of light and electricity for daily life. The students in group were creatively and successful in constructing the models of simple technology assigned such as bulb projector, smartphone projector, a bell, doorbell and simple door alarm. It was suggested that the construction of the instruments should be better (fixed and strong structure) and more attractive for both instruments, and used strong light source, high quality images for projector, and it could use speaker box for projector, power battery, and heat sink for electrical instruments.

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