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STEM-BASED LEARNING IN THE 21ST CENTURY

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Abstract: In the 21st century, education is becoming increasingly important for shaping students to have learning and innovating skills, skills in using technology and information media, and also to be able to work, and survive using life skills. Based on pisa report, Indonesian children's language literacy, science and mathematics scores were on low rank. The Low literacy of Indonesian students in these three aspects is due to the low quality of human resources (teachers and education officer), the low quality and quantity of educational facilities and infrastructure, and the low quality of the learning process. Science learning in the context of technology and design is very potential to improve science literacy. science technology, engineering and mathematics (STEM), is a learning approach /model that is currently rebuilt in various developed countries such as America and. STEM-based learning is one of the potential alternative learning used to build 21st century skills. STEM-based learning can be packaged in terms of cooperative learning models, Problem based learning, Project based learning.

Keywords: *21st Century Learning; Science Learning; STEM*

A. INTRODUCTION

The 21st century makes the development of the world faster and more complex. These changes are essentially aimed at improving the quality of life of modern society. The 21st century can also be said to be a century marked by a major transformation from an agrarian society to an industrial society and continued into a knowledge society (Soh, Arsyad & Osman, 2010). In Sidi (2003), Richard Crawford referred to the transformation process of the 21st century as the Era of Human Capital an era in which science and technology, especially communication technology, developed so rapidly that it impacted free competition so intensely in all aspects of human life.

Mastery of Science and Technology (Science and Technology) is now an important key in dealing with the challenges of the 21st century. Various challenges include improving quality of life, equalization of development, and the ability to develop human resources. According to Prayekti. (2006) , Science education plays an important role in preparing students who have science literacy, who are able to think critically, creatively, logically, and take initiative in responding to social issues as a result of the development of science and technology.

Miller (1998) points out that science literacy is defined as the ability to read and write about science and technology. Furthermore, a person's ability in science is heavily influenced by a systemic, logical and rational way of thinking, which is very potentially trained in mathematics. Both of these abilities will be used to conduct critical analysis of a phenomenon in science, using it as well when a person is solving problems related to the context of science. The ability to think logically and rationally is one aspect of mathematical literacy. A man with mathematical literacy will usually have the ability to think of phenomena found logically, systemically, and based on critical thoughts.

Literations of Language, mathematics, and science are recognized internationally as a benchmark for high-quality education It is responded to by The Program for International Student

Assessment (PISA) which consists of developed industry countries (the Organization for Economic Cooperation and Development, OECD). The organization considers that the rewind of a nation is determined by the three literacy, so it always conducts periodic assessments every three years, especially against students aged 15 years (junior high school level). In addition to developed industrial countries, assessments are also conducted in countries that apply to be assessed, including Indonesia. However, science literacy in Indonesia tends to be low, this can be known through the PISA (Program for International Student Assessment) report released on Tuesday 3 December 2019 that the science score for Indonesian children is ranked 70th out of 78 countries.

Some research shows that science learning in the context of technology and design has the potential to improve science literacy. Students can define more in the importance of science for technological development, and vice versa. STEM (Science, technology, engineering and mathematics) education is now an alternative to science learning that can build a generation capable of facing a challenging 21st century.

B. DISCUSSION

1. 21ST Century Learning

The development of the 21st century world is marked by the progress and demands of the times. Human resources are starting to be replaced with technology so that all can become easier and more practical. This is demonstrated by the many applications of advanced technologies in the form of applications that provide the need to facilitate human survival.

There are seven types of life skills needed in the 21st century. Wagner (2010) states the seven skills needed in the 21st century are (1) critical thinking and problem-solving skills, (2) collaboration and leadership, (3) dexterity and adaptability, (4) initiative and entrepreneur spirit, (5) being able to communicate effectively both orally and in writing, (6) being able to access and analyze information, and (7) having curiosity and imagination.

In the 21st century, education is becoming increasingly important to ensure students to have learning and innovating skills, skills using technology and information media, and being able to work, and survive using life skills. The Ministry of Education and Culture of the Republic of Indonesia has adapted three 21st century educational concepts to develop a new curriculum for elementary school, junior high school, high school and vocational high school. The three concepts are 21st Century Skills, scientific approach and authentic assessment.

Furthermore, the three concepts were adapted to develop education towards Creative Indonesia in 2045. Adaptation is done to achieve the conformity of the concept with the capacity of the students and the competence of educators and their educational personnel. 21st century skills are (1) life and career skills, (2) learning and innovation skills, and (3) Information media and technology skills. These three skills are summarized in a scheme called rainbow knowledge-skills rainbow (Trilling and Fadel, 2009).

The 21st century demands education to prepare students who are able to face global economic competition. The Partnership for 21st Century Skills emphasizes that 21st century learning must teach 4 competencies namely communication, collaboration, critical thinking, and creativity. Frydenberg & Andone (2011) also states to face learning in the 21st century, everyone should have critical thinking skills, knowledge and digital literacy skills, information literacy, media literacy and mastering information and communication technology.

Learning in the 21st century has standards as a reference for achieving learning goals. Through established standards, teachers have clear guidelines on what is taught and what to achieve. Advances in information and communication technology have changed people's lifestyles, whether working, socializing, playing or learning. Entering the 21st century these technological advances have entered various joints of life, no exception in the field of education. Teachers and students, lecturers and students, educators and learners are required to have the ability to learn to teach in the 21st century. A number of challenges and opportunities must be faced by students and teachers in order to survive the century of knowledge in this information age (Yana, 2013).

2. Science and Technology Literacy

According to the 2006 National PISA, science literacy is defined as the ability to use science knowledge, identify questions, and draw conclusions based on evidence, in order to understand and make decisions regarding nature and changes made to nature through human activity. This definition of science literacy considers science literacy to be multidimensional, not just an understanding of science knowledge, but broader than that PISA 2000 states that science literacy also demands the ability to use the process of science investigation, such as identifying the evidence necessary to answer scientific questions, knowing problems that can be solved through scientific research.

Technology is a part that can't be separated from science. The development of technology is based on science while the technology itself supports the development of science, mainly used for discovery activities in an effort to obtain explanations about objects and natural phenomena. Solihatun, says that technology is a hardware and software that is used to solve problems for the fulfillment of human needs.

Based on these definitions, it can be abstracted that science and technology literacy is the ability to use science knowledge and its application, identify problems and draw conclusions based on evidence in understanding and making decisions about nature and changes in nature as human activity in daily life. As for the science and technology literacy proposed for basic education in Indonesia, it can be interpreted as the ability to solve problems using science concepts, know technology products and their impact, be able to use and maintain technology products, be creative, and can make decisions based on the prevailing values in society.

According to the National Science Teachers Association (NSTA,2000), a person with science and technology literacy has the following characteristics:

a) Use the concepts of science, process skills and values when making responsible decisions in daily life.
b) Know how society affects science and technology and how science and technology affect society.
c) Know that society controls science and technology through the management of natural resources.
d) Be aware of the limitations and uses of science and technology to improve human well-being.
e) Meet most concepts of science, hypothesis and science theory and be able to use them.
f) Appreciate science and technology as an intellectual stimulus.
g) Know that scientific knowledge depends on inquiry processes and theories.
h) Distinguish scientific facts and personal opinions.
i) Recognize the origin of science and know that scientific knowledge is tentative.
j) Know the application of technology and decision making using technology.
k) Have enough knowledge and experience to reward research and technology development.
l) Know the sources of information from science and technology that are trusted and use those resources in decision making.

The main problem in science learning that until now has not received a complete solution is that students find it difficult to understand the concept of science. Hasil research conducted by Holbrook (2005) shows that science learning is irrelevant in students' views and dislikes students. The main factors because there is no connection in science learning. The emphasis on understanding the basic concepts and basic understandings of science is not associated with matters related to daily life, whereas Yager and Lutz in Holbrook, J. (1998) further reveal that science is relevant to the daily processes and products used in society. One of the other obstacles of learning science is due to the low ability to read and interpret reading. According to Permanasari (2010) The ability to think logically, rationally, and systematically students is also low for most Indonesian children.

3. Language Literacy

Science and technology literacy cannot be separated from language literacy (reading). Language literacy can be interpreted as deep ability:-words, writing easily and pleasantly,

conveying essential ideas through written words, and understanding spoken messages (Damaianti et al 2004). In reading, there are at least six words to be known: literacy, iliteration, alliteration, literate, iliterat, and aliterat.

The meaning of the word literacy is the ability toread, Iliteracy means inability to read, alliteration, meaning lack ofreading, Mikulecky (1979), argues that Aliteracy... may guarantee continued, lifelong functional illiteracy. literate is a form of adjective which means it can write and read in a language. Carrol (1984) said: "A person is literate who can, with understanding, both read and write a short, single statement on his everyday life". Iliterate is a form of adjective which means it cannot read. The last word is that the word aliterat is a form of adjective of the word alliteration, i.e. unwilling to read.

Reading activities today no longer appear to be a body of skills and a different process from other areas of literacy. The obvious relationship between reading and writing has been expressed by a number of experts, According to Klein, M.L. (1991), Literate people should be able to write easily. The ability to communicate through writing is a necessity of contemporary society. Students who read well tend to be good writers.

In addition, oral language forms the development of reading ability that makes spoken language very important for reading teachers. Thus, it can be said that the root of the reading activity is spoken language. This does not mean that the importance of reading should be narrowed down. The development and dishargence of literacy remains emphasized through reading. Reading is a key component to any definition of language literacy.

4. Mathematics Literacy

Science and technology literacy is inseparable from mathematical literacy. Technology products produced based on science, are generally always bridged by mathematical literacy. Mathematical literacy is defined as an individual's capacity to identify and understand the role that mathematics plays in the world, to solidify judgment, and bind mathematics in a way that suits the needs of current and future individuals as constructive, caring, and reflective citizens (De Lange, J. 2000).

More operationally the OECD PISA states that a person with mathematical literacy will have the ability to: (1) know and interpret the mathematical problems faced in dailylife (2) translate these problems into mathematical contexts (3) using mathematical knowledge and procedures to solve problems (4) Interpret results into original problems (5) reflecting on the methods used, and (6) formulating and communicating the results.

Based on the above description, it can be concluded that the literacy of science and technology, language, and mathematics shows strong interconnectedness. A person with science and technology literacy performs critical, rational, and thematic thinking by using symbolic language to solve science problems, which will certainly be demonstrated when he or she has mathematical literacy. A person who has science literacy, will use his or her ability to communicate and speak symbolic languages and define science phenomena if he or she has language literacy.

Based on the newly released PISA report, Tuesday 3 December 2019, Indonesia's reading score is ranked 72nd out of 77 countries, then the math score is ranked 72nd out of 78 countries, and science scores are ranked 70th out of 78 countries. The Low literacy of Indonesian students in all three aspects due to the quality and quantity of human resources (teachers and education offiicer), the quality and quantity of educational facilities and infrastructure, and the quality of the learning process

Research and development of various models and approaches in learning needs to be done. Using learning models and approaches that position students to learn, be active, creative, and innovative needs to be trained to prospective teachers. Contextual teaching learning (CTL), science technology, engineering and mathematics (STEM), science, technology, engineering and society (STES), are some of the approaches/learning models that are currently being rebuilt in developed countries such as America and Japan, and already Indonesia should adopt and adapt them according to the conditions we face.

5. Mathematics Literacy

Key to success in realizing the learning achievements that have been formulated is accuracy in choosing a learning approach. The approach needed to science learning is one that can encourage students to be able to solve problems in life both individually and in groups by applying knowledge and utilizing technology as a form of care and contribution to the improvement of environmental quality responsibly. In general, the application of STEM in learning can encourage students to design, develop and utilize technology, hone cognitive, manipulative and affective, and (Kapila, V. & Iskander, M, 2014). Therefore, STEM application is appropriate for science learning. STEM-based learning can train students to apply their knowledge to design as a form of environmental problem solving by utilizing technology.

STEM has been applied in a number of developed countries such as the United States, Japan, Finland, Australia and Singapore. STEM is an initiative of the National Science Foundation. The goal of STEM implementation in the United States is to make these four fields (science, technology, engineering, and mathematics) amajor career choice for students (Han, S., Capraro, R. & Capraro, M. M,, (2014). This situation occurs because the country is experiencing a crisis of scientists in stem fields. The seriousness of the United States government to address the problem is to establish STEM Education and provide tuition assistance to prospective students who choose one of the STEM fields (Jones, L. C., Tyrer, J. R. & Zanker, N. P, 2013). But in recent years, STEM has been applied to various fields of study or majors at various levels of education.

STEM implementation is able to increase knowledge mastery, solve problems, and encourage students to innovate. Integrative STEM enables a variety of learning methods to be used to support their implementation (Sandi-Urena, S., Cooper, M. & Stevens, R., 2012). Referring to the wedge between science literacy and creativity with learning achievements, It was found that a number of research results supporting the use of Problem Based Learning and Project based learning in realizing both competencies. Problem Based Learning can give students the opportunity to apply knowledge to issues as a form of problem solving. Indirectly, the use of PBL also encourages students to master the knowledge necessary to solve the problem. This knowledge can be either information or data that is then used as a consideration material to choose the right way of solving the problem through logical, critical, and systematic thinking. The results of Parwati's research in an environmental context show that STEM learning can build creativity and environmental literacy, which is indispensable to dealing with the 21st (Parwati, R, etal, 2015).

The use of project based learning is also able to lead students to solve the given problem and put more emphasis on the resulting product (ChanLin, L.-J., 2008) resulting from the use of project based learning in science learning can be a contribution of students to improving quality of life. Problem solving in the life and manufacture of its products can be done individually as well as in groups. Group work can encourage students to work together but remain responsible for their work independently. In addition, in groups of students can do self-learning that matches the state of each group. This pattern of learning can be accommodated by cooperative learning (Filippatou, D. & Kaldi, S. , 2010).

Based on the above description, it can be said that Problem Based Learning, Project based learning, and cooperative learning can support the application of STEM to science learning. Even the combination of STEM implementation with Project based learning, can encourage cooperation between educational institutions and industry. From the above exposure it can be said that all learning achievements accommodated by science subjects can be realized through stem implementation supported by Problem Based Learning, Project based learning, and cooperative learning. Because the achievement of learning is sliced with science literacy and creativity, it can also be said that STEM-based learning supported by PBL, PjBL, and cooperative learning is expected to algorithmize both competencies. Several studies in Indonesia have been conducted showing that STEM learning can improve science literacy, creativity, and the problem solving ability.

C. CONCLUSION

The literacy of science, language and mathematics is a feature of the forward and backward of a nation. The phenomenon related to the low literacy of Indonesian children in all three types of literacy shows the need to improve the quality of education in Indonesia. Institutions, and schools

are expected to spearhead science education. Therefore, there is a need of alteration, innovation, and reformation in the learning of prospective teachers from the use of the old paradigm to the new paradigm. Building content mastery must be done through the process of providing skills, based on good attitudes, characters, and habits. Remember that the end of an educational process is essentially instilling personality. STEM-based learning is one of the potential alternative learning used to build 21st century skills. STEM-based learning can be packaged in cooperative learning models, Problem based learning, Project based learning and more. Remember, too, that Indonesia has grand design in the education of this character since our ancestors, namely spiritual and emotional development, intellectual development, physical and kinesthetic development, and affective and creative development. With this soul, we must be confident that STEM learning will be able to minimize side effects that we do not want.

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