STEM Learning To Improve Basic Students 'Critical Thinking Ability

Diah Kusumawati[a*] Heny Sulistyaningrum[b]

Universitas PGRI Ronggolawe Tuban, Indonesia

*email address: kusumawatidiah021@gmail.com

Abstract

STEM (science, technology, engineering, and mathematics) learning is currently an alternative science learning that can build a generation capable of facing the 21st century. The skills that must be possessed in the 21st century are known as 4C which consists of critical thinking, collaboration, communication, and creativity. Critical thinking is the ability to understand a complex problem, connect information so that various alternative solutions will emerge, and find solutions to a problem. The purpose of this study was to explain about STEM learning in improving the critical thinking skills of elementary school students. This type of research is a literacy study, which is conducting a literature review of books, journal articles, and other documents related to increasing the critical thinking skills of elementary school students through STEM learning. The results of the study can be concluded that there are three integration patterns in STEM learning, namely the silo approach pattern, the embedded approach pattern, and the integrated approach pattern. STEM learning requires students to have the knowledge and skills simultaneously to solve a problem and train students to apply their knowledge as a form of problem-solving related to the environment by utilizing technology. Therefore, STEM learning can improve students' ability to think critically.

Keywords: STEM learning ; Critical Thinking Ability

1. Introduction

STEM (Science, technology, engineering, and mathematics) education is currently an alternative science learning that can build a generation capable of facing the challenging 21st century (Permanasari 2016). The skills that must be possessed in the 21st century are known as 4C which consists of critical thinking, collaboration, communication, and creativity. These four abilities are what students need to face the challenges of the 21st century.

One of the 21st-century skills that students must master is critical thinking. Critical thinking ability is an aspect that needs to be developed in the learning process (Cintamulya, et al, 2020). Critical thinking is the ability to understand a complex problem, connect information so that various perspectives will emerge, and find solutions to a problem. Critical thinking skills also describe other skills such as communication and information skills, as well as the ability to examine, analyze, interpret, and evaluate evidence (Zubaidah 2019).

Critical thinking skills are fundamental skills in learning in the 21st century. In the era of digital literacy where the flow of information is very abundant, students need to have the ability to choose relevant sources and information, find quality sources and assess

sources from the aspects of objectivity, reliability, and recency (Zubaidah 2019). The traditional approach that emphasizes memorization will not develop students' critical thinking skills or independence. Learning design plays a central role in the success of 21st-century learning. Teachers' creativity and ability to design interesting learning activities are needed. One of the learning approaches to improve students' critical thinking skills is the STEM approach.

STEM has been implemented in some developed countries such as the United States, Japan, Finland, Australia, and Singapore (Permanasari 2016). STEM was launched by the US National Science Foundation in the 1990 as the theme of the educational reform movement in these four disciplines to grow the STEM field workforce, develop STEM-literate citizens, and increase US global competitiveness in science and technology innovation (Oktapiani and Hamdu 2020). The development of STEM education in Indonesia has become an interesting area of study in recent years (Yanthi et al. 2019).

STEM learning is currently very much needed in the world of education to help students fulfill 21st century skills, one of which is thinking skills, because thinking skills for students in Indonesia are still low, especially in the fields of science and mathematics (Haryati, Lidinillah, and Karlimah 2020) .By using the STEM approach, the learning process will be more varied and innovative so that you can learn various academic concepts juxtaposed with the world real. STEM learning can help students acquire complete knowledge, be more skilled in dealing with real-life problems and develop thinking critical students. STEM is an effective approach in implementing learning Thematic Integrative because it combines four main areas in education, namely science, technology, engineering, and mathematics. STEM has been defined as the connection between disciplines of integrating technology and engineering practices into current mathematics and science lessons (Bybee, 2013)(Shidiq and Faikhamta 2020). STEM (science, technology, engineering, and mathematics) has become a proxy for careers that, from the viewpoint of our nation's leaders, are essential for economic security and, from the viewpoint of parents, are gateways to well-paying jobs ("STEM Learning" 2016)..

Research on STEM learning has been carried out by many previous researchers, especially at the Middle School level. However, this research has not linked STEM learning with the improvement of students' critical thinking skills, especially at the elementary school level. Therefore, this study discusses STEM learning to improve the critical thinking skills of elementary school students.

2. Research Method

This research is a conceptual study through document analysis in the form of literature study. The form of this research is descriptive qualitative in the form of a description of a certain situation. This research is a qualitative type through library studies. The research phase is carried out by collecting library resources, both primary and secondary ("Metode Penelitian Kualitatif Studi Pustaka," n.d.). This type of research is literacy study, which is conducting a literature review of books, journal articles, and other documents related to increasing the critical thinking skills of elementary school students through STEM learning.

2.1. Data collection technique

In this research is content analysis. Content analysis is by recording documents or archives that are closely related to the research objectives. Content analysis is carried out by discussing the concepts of critical thinking and STEM learning. Researchers read and analyze written sources in the form of books, journals, articles, study results from previous researchers and then describe the theories that related to the object of further research, the theory is developed and conclusions are drawn (Rohmah, Zakaria Ansori, and Nahdi 2018).

2.2. Procedure

Data analysis procedure with data reduction, data presentation, and conclusion drawing. Data reduction is done by collecting information and data on the basic concept of school literacy from document collection. Then the presentation of data is done by presenting information by simplifying the meaning and interpreting the information. Furthermore, the withdrawal of conclusions is done by providing conclusions from the results of the study in accordance with the objectives expected by researchers.

3. Result and Discussion

Critical thinking includes the component skills of analyzing arguments, making inferences using inductive or deductive reasoning, judging or evaluating, and making decisions or solving problems (Paul 1990). Critical thinking skill is the ability to think logically, reflectively, systematically and productively which is applied in making good judgments and making decisions (Redhana 2019). Therefore, critical thinking is the ability to understand a complex problem, connect information with one another, so that various perspectives will emerge, and find solutions to a problem.

Broadly speaking, the critical thinking behavior above can be divided into several activities:

1. Question centered
2. Argument analysis
3. Asking and answering questions for clarification
4. Evaluate the correctness of information sources.

Students' critical thinking skills cannot be separated from the science learning process at school. One alternative approach to learning science in schools is STEM learning. STEM education is an approach to learning that combines science, technology, engineering and mathematics to solve problems in everyday life and develop students' creativity (Haryati, Lidinillah, and Karlimah 2020). Moreover, STEM is one method in teaching approach that can provide promising studies by providing evidence which focuses on facilitating students to understand the world as a whole rather than in parts (Shidiq and Faikhamta 2020).

In general, the goal of STEM education is to increase global competitiveness in the field of science and technological innovation including increasing understanding in STEM fields for all citizens (Council 2011). In the field of science, students are required to be able to use the natural knowledge they get in solving problems in their daily lives.

In the field of technology, students are required to be able to collaborate in the use of technology to convey information and to process the data found. In engineering, students collaborate on their findings to find appropriate solutions or even create a product. In the field of mathematics, students can use their mathematical knowledge when they process data (Rohmah, Zakaria Ansori, and Nahdi 2018).

Integrative STEM education pedagogy is inherently learner-centered and knowledge-centered (Bransford, Brown, & Cocking, 2000), and when used with groups of learners, provides a remarkably robust environ- ment for the social interaction so critical to the learning process ("STEM, STEM Education, STEMmania," n.d.).STEM approach in lear- ning is expected to give a meaningful learning to students through systematic integration of know- ledge, concept and skills (Afriana, Permanasari, and Fitriani 2016). STEM learning by integrating its four components can produce student thinking activities that are useful to help bring up students' critical thinking which is characterized by the ability to solve problems, make decisions, analyze assumptions, evaluate, and carry out investigations..

According to Rohmah, et al, 2019, the STEM approach needs to emphasize several aspects in the learning process, namely, 1) asking questions (science) and defining problems (engineering), 2) developing and using models, 3) planning and conducting investigations, 4) analyzing and interpreting data (mathematics), 5) using mathematics, information technology, and computers, and computational thinking, 6) building explanations (science) and designing solutions (engineering), 7) engaging in evidence-based arguments, 8) obtaining, evaluating, and communicating information.

During its development, three patterns of STEM learning approaches are commonly recognized by the world of education. These three patterns are known as SILO, embedded, and integrated.

3.1. The SILO Approach Pattern

The SILO approach pattern is an approach pattern that separates each STEM component. The SILO approach to STEM education refers to isolated instruction, where each STEM subject is taught separately or individually. The SILO approach emphasizes how science, technology and engineering, and mathematics education have been approached in curriculum design and teaching. The SILO approach is characterized by teacher-driven learning.

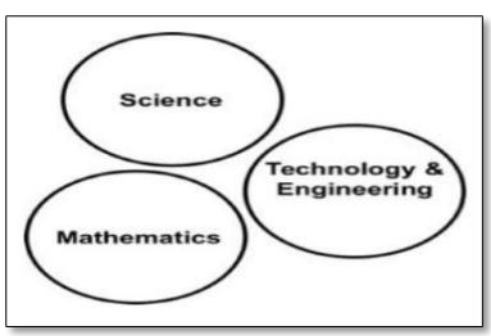

Fig. 1. SILO approach pattern

In Figure 1 above, each circle represents each of the STEM disciplines taught separately. The interrelationship between lessons in this approach is generally conveyed expressly through the teacher's conversation in front of the class. Silo approach patterns are patterns that are less in line with STEM learning.

3.2. EmbeddedApproach Pattern

The STEM approach can be broadly defined as an educational approach where the domain of knowledge is acquired through an emphasis on real-world situations and problem-solving techniques in social, cultural, and functional contexts. In the embedded approach, one content/material takes precedence to pay attention to the integrity of the subject.

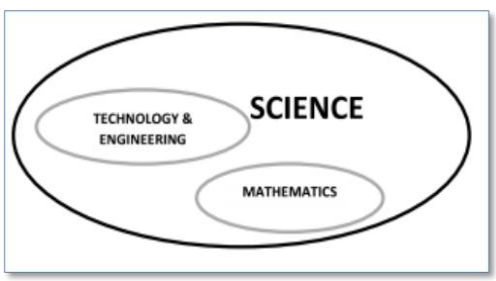

Fig. 2. Embedded approach pattern

In Figure 2 above, the material in the fields of technology and engineering, and mathematics are embedded in Science. In an embedded STEM approach, educational content of technology is emphasized (as will be taught in silo shorts), thus maintaining the integrity of the learning material.

3.3. Integrated Approach Pattern

An integrated approach to STEM education envisages removing the walls between each of the STEM content areas and teaching them as a single subject. An integrated approach is expected to increase interest in the STEM field, especially if it starts at a young age. An integrated approach connects material from different STEM fields taught in different classes and at different times and combines cross-curricular content with critical thinking skills, problem-solving skills, and knowledge to conclude. An integrated approach is the best approach to STEM learning.

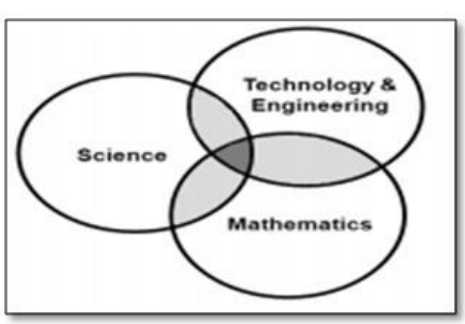

Fig. 3. Integrated approach pattern

In Figure 3 above, STEM materials are taught as if they were a single subject. In theory, the pattern of integration approach with interdisciplinary model is the most difficult approach to do but best suited for STEM learning.

Permanasari (2016: 29) explains that the application of STEM can be supported by various learning methods. Permanasari conveyed that STEM is integrative which allows various learning methods to be used to support its application. Creating STEM-based experiences that feature wide walls encourages students to share and communicate their learning not only within the classroom but beyond, as students convey to others the conceptual surprises they have experienced(English, n.d.).

4. Conclusion

STEM learning by integrating its four components is able to produce useful student thinking activities to help bring about critical thinking. Integrative STEM allows a variety of learning methods to be used to support their application. STEM learning is closely related to the 2013 curriculum that integrates several subjects, namely science, engineering, technology, and mathematics which are then integrated to improve critical thinking skills. From this analysis, STEM learning is considered suitable to be applied to learning in elementary schools conducted thematically-integrated. This conceptual study of STEM learning can be developed through qualitative and quantitative research by combining appropriate learning models.

References

Afriana, J., A. Permanasari, and A. Fitriani. 2016. "Project Based Learning Integrated to Stem to Enhance Elementary School's Students Scientific Literacy." Jurnal Pendidikan IPA Indonesia 5 (2): 261–67. https://doi.org/10.15294/jpii.v5i2.5493.

Cintamulya, I., Warli, and L. Mawartiningsih. 2020. "Critical Thinking Ability after Project-Based Learning: A Comparative Study on Students Who Have Different Cognitive Styles." Journal of Physics: Conference Series 1422 (1). https://doi.org/10.1088/1742-6596/1422/1/012039.

Council, National Researh. 2011. "MENGENAL PENDIDIKAN STEM DAN PENERAPANNYA DALAM PEMBELAJARAN IPA Oleh : Tati , M . Pd STEM : Apakah Dibelajarkan Secara Terpadu Atau Terpisah ?"

English, Lyn D. n.d. "Advancing Elementary and Middle School STEM Education." https://doi.org/10.1007/s10763-017-9802-x.

Haryati, Teti, DAM Lidinillah, and Karlimah. 2020. "Development of the STEM Learning Design in the 2013 Curriculum in Primary Schools: An Analysis and Exploration." Jurnal Pendidikan Sekolah Dasar 3 (2): 71–78.

"Metode Penelitian Kualitatif Studi Pustaka." n.d.

Oktapiani, Nida, and Ghullam Hamdu. 2020. "Desain Pembelajaran STEM Berdasarkan Kemampuan 4C Di Sekolah Dasar." Jurnal Ilmiah Pendidikan Dasar 7 (2): 99. https://doi.org/10.30659/pendas.7.2.99-108.

Paul, Richard W. 1990. "Paul- Critical Thinking: What, Why, and How." Critical Thinking: What Every Person Needs to Survive in a Rapidly Changing World, 45–56. https://eric.ed.gov/?id=ED338557.

Permanasari, Anna. 2016. "STEM Education: Inovasi Dalam Pembelajaran Sains." Seminar Nasional Pendidikan Sains, 23–34.

Redhana, I Wayan. 2019. "Mengembangkan Keterampilan Abad Ke-21 Dalam Pembelajaran Kimia." Jurnal Inovasi Pendidikan Kimia 13 (1).

Rohmah, Ulfa Nadiyatur, Yoyo Zakaria Ansori, and Dede Salim Nahdi. 2018. "Pendekatan Pembelajaran Stem Dalam Meningkatkan Kemampuan Literasi Sains Siswa Sekolah Dasar." Pendekatan Pembelajaran Stem Dalam Meningkatkan Kemampuan Literasi Sains Siswa Sekolah Dasar 5 (3): 152–62. google schoolar.

Shidiq, Galih Albarra, and Chatree Faikhamta. 2020. "Exploring the Relationship of Teachers' Attitudes, Perceptions, and Knowledge towards Integrated Stem." Elementary Education Online 19 (4): 2514–31. https://doi.org/10.17051/ilkonline.2020.764619.

"STEM, STEM Education, STEMmania." n.d.

"STEM Learning." 2016. https://doi.org/10.1007/978-3-319-26179-9.

Yanthi, N., B. Milama, H. Choirunnisa, and M. S. Yuliariatiningsih. 2019. "STEM Learning Content in Elementary School National Curriculum." Journal of Physics: Conference Series 1318 (1). https://doi.org/10.1088/1742-6596/1318/1/012052.