Urgency of STEM Learning Application in Early Childhood Education: A Review of Literature

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***Abstract*— The issue of the existence of the technological revolution 4.0 in a mid-Indonesian society, especially Aceh, encouraged educators to continue to transform the education system. It is, of course, related to the challenges of teachers' readiness, including early childhood teachers, in shaping a smart and intelligent generation of Aceh in the global industrial era of 2045. In the future, each generation of Aceh will become a public need and is expected to be able to compete from all sides of life both locally and internationally. With the rapid development of appropriate technology in education, the skills of early childhood teachers are needed in modifying learning. Thus, it can sharpen the mind of students in the fields of science, technology, language, and art. Based on today's data, education in Aceh is left behind in other regions in Indonesia. This is far from the reality and expectation of the motto "Aceh Carong". This phenomenon continues to motivate educators to renovate and find solutions until the education system can educate its generation according to technological needs. The application of the STEM approach is seen as an innovation in modern education to improve scientific and creative thinking skills. This literature study can answer the objectives, potential, and challenges of STEM application in early childhood education. The study findings are also expected to increase teacher understanding of the importance of applying this approach in early childhood learning and to support the practice of teacher professional development in the future.**

Keywords: Challenges, Objective, STEM, Early Childhood Education

I. INTRODUCTION

The phenomenon of the Industrial Revolution and Technology 4.0 have an impact on the 21st-century education system and significant social implications on job creation, employment opportunities, equality, and sustainable development in Acehnese society. Lately, the education sector has become a major concern for the Aceh government through its programs, Aceh's glorious and Aceh's carong. This encourages the government to continue to renovate the education curriculum system in Aceh, which has standardization of elements of character, and values of local wisdom and follows the development of children. Schools and teachers are equipped with relevant learning tools, methods, and approaches to prepare a generation that is reliable and capable of using technology. Aceh's generation has the opportunity to develop their skills. By having higher-order thinking skills, they will have the competency to develop science and be able to compete both locally and internationally.

Creating a generation with intellectuals and good characters requires a model of an appropriate education system, of course, based on the needs in Aceh. The focus of the education system is on preparing students for higher education, equipping them with the skills and knowledge they need to become successful innovators in the world of work. Some recent studies discuss the role of the STEM

approach that can stimulate meaningful learning in the 21st century and STEM is seen as a simple approach in its application in the learning process. STEM began to be developed initially in developed countries, and its application has begun since early childhood education. Hilary Asoko (2000) regards the application of the STEM curriculum as not only describing the purity of science, but the synergy of technology that is integrated with the fields of engineering, art, and mathematics in a simple, basic, natural way, and can be implemented in everyday life. This STEM knowledge is cumulative which means to learn about new things, children must construct knowledge through the construction of previously owned knowledge. Thus, it becomes important to teach STEM development from an early age, related to the formation of the concept of STEAM at the next level and THE PROVISION OF INITIAL STEAM knowledge in early childhood will stimulate their intelligence from various aspects in the fields of science, technology, engineering, and mathematics.

I.1 *STEM (SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS)*

STEM was designed by the National Science Foundation (DeCoito, 2014), which is a combination of Science (the study of the natural world), Technology (the study of products made to meet human desires or needs), Engineering (the design process used to solve problems), and Mathematics (the language of shapes, numbers, and numbers). STEM is not only a grouping of fields of study but is a "fusion" and holistic approach to solving problems. STEM is designed to develop various 21st-century skills that can be used in all areas of daily life, such as reasoning, problem-solving, critical thinking, creative and investigative skills, independent learning, technological literacy, teamwork and collaboration, and various other skills. STEM learning intends to integrate various subjects into an integrated curriculum.

1.1.1 Objectives/ Purpose of Steam

STEM learning supports Industry 4.0 goals with the 21st-century skills needed (Idin, 2018). The model also shows important indicators that STEM learning must be improved so that the community is ready to have skills in high-quality industries. Through STEM learning designed, students can solve real-world problems (Buckner & Boyd, 2015). Students can learn the engineering design process, where they identify and define problems, conduct research, develop several ideas for solutions, and arrive at one idea that they design, test, evaluate and make improvements to the prototype. Through this process, students can learn many social skills, collaboration, teamwork, leadership, open exploration, direct inquiry, and natural learning and can engage in deeper learning, to develop a good and strong mindset where "failure" is considered a positive step towards improvement and better solutions.

I.2 *STEM CHALLENGES (SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS)*

STEM learning arises in response to the need to increase students' interests and skills in the fields of Science, Technology, Engineering, and Mathematics. STEM aims to increase student involvement, creativity, innovation, problem-solving skills, and other cognitive benefits (Liao, 2016), and to improve the work skills (eg teamwork, communication, adaptability) needed for careers and economic progress (Colucci-Gray et al., 2017).

The STEAM concept is explained in various ways, with at least four types of discipline integration: transdisciplinary, interdisciplinary, multi-disciplinary, and interdisciplinary (Marshall, 2014). STEAM as a transdisciplinary involves the full integration of these various disciplines and their learning rooted in authentic or inquiry issues. STEAM as an interdisciplinary combines several disciplines under a general theme, but each discipline remains separate. STEAM as a multidisciplinary includes collaboration between two or more disciplines but not combined (Payton, White, & Mullins, 2017). Finally, cross-disciplinary STEAM focuses on observing one discipline

from another scientific perspective. Modifications to the development of the initial term STEM then added art to STEAM, but the character curriculum also had an important impact, so the term change became STEAM-C.

I.3 *STEM LEARNING*

The 21st century has opened up new horizons for "complex design systems that are non-linear and holistic", which require cross-disciplinary approaches and new conceptual principles and tools. Schools are expected to not only teach disciplines from simple to complex reductionism but also need the ability to deal with them. This requires an adequate creative curriculum that is "not traditional". Triggering creativity in STEM learning is needed to improve students' thinking to be more independent and flexible, as well as creative self-efficacy and creative problem-solving skills. Creativity is developed through a supportive environment in which students feel encouraged to think independently, explore and play, observe and reflect, and ask unusual questions. Creativity can also be fostered through examples and practices (Root-Bernstein, 2015), therefore teachers must model creative behavior and build the independence of creative students through feedback that supports and encourages creative processes. It shows that STEM learning aims to develop student creativity or as a means to improve real-world problem-solving skills. Wilson & Hawkins (2019) show that STEAM learning makes students appreciate how art and science together use many forms of critical thinking skills, creativity, and imagination when they try to understand real problems. Therefore, curriculum support is needed to foster transdisciplinary talents and expertise, compared to "traditional" ways of looking at domains and disciplinary boundaries. Such support will create a variety of relationships that are more comprehensive and imaginative. Perignat & Katz-Buonincontro (2019) states that, although various models are proposed to develop creativity as part of STEAM learning, STEAM educators often experience difficulties in developing student creativity.

Taylor (2016) gives the following important points. (1) STEAM learning does not conflict with STEM learning but it enriches and broadens its scope. (2) STEAM learning is a curriculum philosophy that empowers science teachers in developing the humanistic vision of 21st-century education. (3) STEAM learning also provides creative design space for teachers in various fields of learning to collaborate in developing integrated curricula. (4) Learning STEAM on a simple scale can be designed and implemented by an innovative teacher. (5) STEAM educators can take inspiration from project-based learning. (6) STEAM learning involves students in transformative learning, which is based on five ways of interconnected knowledge: cultural knowledge, relational knowledge, critical knowledge, visionary and ethical knowledge, and knowledge in action. The involvement of students in STEAM subjects aims to spark interest and love for science and art in children from an early age. STEAM involves a creative process and no one uses only one method for the process of discovery and investigation. Learning that is relevant in preparing students to become innovators in a developing world is very important, not only for the future of students today but for the future of the nation.

1.4 THE IMPORTANCE OF LEARNING STEM IN EARLY CHILDHOOD

STEM learning is considered important and recommended because in this learning children are trained to be able to be creative, innovative, and independent. The focus on learning is that children are trained to have more skills or abilities by integrating four types of learning at one time or one learning activity. The stimulation of the STEM method will encourage children to think more critically and logically so that mentoring parents and teachers (for those who are already in school) is important ". Initially, only STEM was known, but as the need for STEM grew, it was also of artistic value and character. STEM learning methods combine five fields of science in one activity, namely science, technology, engineering, art, and mathematics which are often abbreviated as STEAM-C. The purpose of integrating this field of science is so that children are more absorbed and deepen the lessons given. STEAM-C is considered a fun and memorable learning method for children, memorable and exciting learning for children will form a strong motivation within the child.

Especially for inquisitive young children, providing STEAM-C-based learning will make it easier for children to form constructs of smarter thinking because in STEAM-C learning children are trained in cognitive abilities, especially their reasoning abilities. For this reason, if the STEM approach is to be modified in the K13 curriculum, the government engaged in education needs to increase the competence of pre-mastered teachers through special training on steam implementation in early childhood learning through the K13 curriculum. So that not only the curriculum is modified but also the teacher is given a uniform understanding and competence.

STEM aims for better education by applying the latest methods that are more efficient and innovative. But that does not mean STEAM is accepted and easily practiced by educators rather there are diverse obstacles in educators, one of which is a constraint in terms of sufficient content knowledge of each subject, conceptual relationship between the domains of knowledge provided, understanding of the scientific process, and difficulties in how integrating effective STEM learning. Achieving the successful application of STEM learning requires more than improvement in pedagogy and curriculum. Changes in various matters include professional development for teachers, teacher and student mentoring opportunities, external partnerships (to bridge the gap between academic knowledge and concrete applications), and school or regional approaches. DeCoito (2014) also believes that integrating STEM subjects can contribute to various competencies and learning outcomes (including problem-solving, critical thinking, and making real-world connections), but this can often also be a problem for educators.

Besides, the challenges experienced by education in using steam in learning are that careful planning is needed, both in terms of the budget of funds needed, the place of learning to be used must be under the theme of learning, and teachers need to identify what resources courses available that relate to learning themes and to use the steam learning model, curriculum development is needed so that everything that students learn at school relates to daily life. Thus, students feel that all learning material that is obtained at school is very useful in everyday life.

STEAM-based learning aims to form early-aged learners to be innovative, creative, independent, and skilled at developing their potential and abilities to face the development of the future, one of which is 4.0. Facing the challenges of the 21st century, steam learning is very important to be applied in Indonesia, because STEAM learning makes children able to have high reasoning power and qualified creativity. Children will apply the five fields of science that exist in themselves in an integrated and structured manner, and the result makes children produce concrete works that can compete and benefit the surrounding environment.

II. METHODS

The research method used is the study of literature, which is a method in research by examining a lot of relevant literature as a reference for writing. According to I Made Indra and Ika Cahyaningrum (2019) a literature study is a descriptive survey in gathering data relevant to the problem or topic studied based on the literature as the main reference. So literature studies obtain data from all written sources that are tested for interpretation and meet the criteria to be used as literature in writing. Writing data collection is done in several ways such as documentation studies, reading books that are reviewed, and following research topics, journals, and previous research. So simply put, in the study of literature the author obtained data from written sources that have a strong theoretical foundation and are relevant for use.

to compare the results of program implementation in the responsive parenting participant group and the non-participant group. Quantitative data were collected in person with strict COVID-19 health protocols.

III. RESULTS AND DISCUSSION

III.1 *THE IMPORTANCE OF LEARNING STEM IN EARLY CHILDHOOD*

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IV. CONCLUSION AND RECOMMENDATION

STEM is a learning method that integrates several fields of knowledge in learning activities, namely science, technology, engineering (the process of making works), art (art), and mathematics. Some fields of science are then integrated into one learning activity. Children are given the field of learning in one learning process to train children's abilities, namely cognitive and motor skills, skills for creativity and innovation, and independence and ability to compete to create benefits for the surrounding, especially in the 21st century with a period known as 4.0. Steam for young children is not complicated steam, but STEAM is sorted from simple activities, that can be applied easily, safely, and fun to children by following the children's development-based education curriculum.

STEAM learning for young children is intended to train early children to be skilled in developing their potential and skills to be able to deal with future developments with a variety of concrete works. Especially the next generation of the nation in Aceh. Efforts to realize the ideals of the government and the people of Aceh, Aceh Great, Aceh Carong, are needed to update learning methods that are appropriate to the times and students so that harmony is formed, so one of the efforts is to apply the STEAM method in education by both teachers and parents.

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