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Exploring The Knowledge And Experience Of Childhood Education Teachers On Steam Education In Indonesia

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Abstract

This study investigates early childhood teachers' knowledge and experiences with STEAM education after participating in STEAM learning training in professional education in Indonesia. The research participants were 51 teachers who had completed professional education and worked in raudhatul athfal, or Islamic kindergartens. Participants completed a test consisting of thirteen knowledge items in the form of closed questions and group interviews to describe teachers' experiences implementing STEAM education. The findings show that after attending training, teachers' knowledge of STEAM education increases, and teachers have experience in selecting the best method, affordable media, and collaborating with material experts in STEAM learning. Teachers also stated that they required the availability of learning media and learning collaborators. Despite having received professional education, the majority of early childhood education teachers in Indonesia require the availability of media and collaborators in STEAM education, according to the findings of this study. The implications and recommendations for the future are also discussed.

Keywords: STEAM Education, Teacher Knowledge and Experience, Early Childhood

Introduction

STEAM is a modern form of education that was developed in the United States in 1990 by integrating previously considered separate and distinct educational domains. The term STEAM was coined in the field of education to refer to the integration of science, technology, engineering, and mathematics. However, education experts have expanded to include art, giving rise to the term STEAM (Robelen, 2011). STEAM stands for Science, Technology, Engineering, Art, and Mathematics. Early childhood is expected to be able to connect their knowledge in the fields of

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science, technology, engineering, and mathematics with the arts through this learning. This approach is ideal for children who absorb information like a sponge (Montessori, 1949), and the STEAM learning model can boost creativity and problem-solving skills in early childhood (Yalçn & Erden, 2021).

The Indonesian government has proposed STEAM as a model for early childhood education in order to improve the quality of children's education and prepare them for the educational needs of the twenty-first century. As a result, STEAM learning is one of the materials studied in teacher professional education. The use of STEAM practices will have a greater impact on the development of competence in children aged 3-6 years (Monkeviciene et al., 2019). However, the challenge is that teachers' ability to implement STEAM learning still needs to be improved so that STEAM education is of high quality (Yang et al., 2021). Several studies have revealed that prospective or teachers require training to implement STEAM education in early childhood (Moghal et al., 2020; Sawangmek, 2019; Wan et al., 2021). Given that Indonesia started promoting the use of the STEAM model in early childhood education institutions in 2018, it is necessary to investigate teacher knowledge and experience with STEAM education for teachers who have attended professional education. The purpose of this study is to ascertain the knowledge and experience of early childhood teachers who have received professional education in STEAM education.

RESEARCH METHOD

STEAM Education in Early Childhood Education

STEAM education is very compatible with the nature of children, who like to ask questions as a result of their innate curiosity. Curiosity drives children to seek answers by establishing relationships between objects and/or concepts using novice reasoning. Children may not always find answers in this situation, but it can serve as a starting point for them to think critically. When their experience is insufficient, they will begin to develop cognitive skills, and creative thinking solutions will emerge. Cognitive skills are a scientist's capital in conducting observations, collecting data, analyzing data, and drawing conclusions through induction and deduction (Seçil Yücelyiit, 2017, p. 408). The STEAM learning model encourages children to investigate various possibilities in order to produce appropriately while solving problems (Ramsey, 2019).

STEAM learning, with its problem-based delivery, integration of disciplines, and problem-solving skills with an integrated approach between science, technology, engineering, art, and mathematics (Cassie F. Quigley, 2019), is very suitable for early childhood who have a natural penchant for activities-related to science and art with high creativity (Wright, 2010, p. 3). The term "child as a scientist" has emerged as a new feature in the theory of early childhood cognitive development (Cook et al, 2011), following the term "child as an artist" proposed previously by proponents of progressive and contemporary education (Boone, 2007). This term refers to Dewey's multisensory learning theory (Taljaard, 2016), Piaget's play-based learning theory (Garwood, 1982), Vygotsky and Cole's social interaction theory (MacBlain, 2018), and Gardner's multiple intelligences theory (Gardner, 2000). The combination of children's abilities as scientists and artists has proven to be a solid foundation for implementing the STEAM learning model in early childhood.

Teacher's Knowledge and Experience of STEM/STEAM

Despite the fact that STEAM education was introduced in America thirty years ago and has since been adopted by many countries, teachers still have limited knowledge and experience in implementing it. Teachers in Lithuania, for example, have implemented STEAM learning practices in early childhood, but they are unable to guarantee the continuous development of children's abilities due to their limited understanding of the learning process (Monkeviciene et al., 2019). When it comes to implementing STEAM education in early childhood, pre-employees and juniors in Turkey acknowledge that there is a lack of time and resources available, a lack of professional development, a lack of knowledge about STEM disciplines, low parental participation, and teachers who are reluctant to collaborate. (Uraş and Genç, 2018) Due to a lack of content knowledge, early childhood education teachers have difficulty planning lessons that

align with STEM education, according to Yldrm (2021). Some pre-service teachers also struggle with interdisciplinary connections (iftçi et al., 2020).

Aside from a lack of knowledge, some early childhood education teachers face a variety of practical challenges related to the availability of adequate time, media, and resource support. As a result, they lack confidence in implementing STEM lessons in early childhood (Wan et al., 2021). An application called M-Steam with Smart Devices has been developed to assist teachers in Korea in implementing STEAM education (Kim et al., 2018). In Indonesia, the government has offered to use media materials that teachers can easily obtain from the environment (loose parts) in the application of STEAM education in early childhood (Siti Wahyuningsih et al., 2020), as have teachers in various early childhood education institutions (Haughey & Hill, 2018).

Since 2014, teachers in Indonesia have participated in a variety of trainings related to the application of STEAM in early childhood. However, many teachers who have attended the training are still able to incorporate STEAM into lesson planning, which is limited to science and mathematics, so that not all elements of STEAM appear in learning (Pratiwi & Santosa, 2021). This is due to the focus of early childhood education institutions, which is pre-literacy and numeracy, and teacher competence in the application of STEAM is still low (Kartini & Widodo, 2020). As a result, teacher competence in STEAM learning must be improved because it affects the implementation of STEAM learning in Indonesia's early childhood (S. Wahyuningsih et al., 2020).

RESULT AND ANALYSIS

This study employs a hybrid research design that combines qualitative and quantitative methods. The method is thought to be more capable of providing comprehensive answers to research questions (Creswell, 2018, p. 39). The study was carried out in two stages, one after the other. The first stage involved collecting quantitative data in the form of pre-test and post-test experimental designs. In the second stage, a qualitative case study research model was used, with ten teachers chosen at random to be interviewed in depth about their experiences implementing STEAM in early childhood.

The participants in the study were 51 early childhood teachers who attended professional education training in 2021 at the Islamic University of North Sumatra Medan. They came from various provinces on the island of Sumatra and ranged in age from 25 to 40 years. The PAUD teacher volunteered to take part in the study. The early childhood teacher had never received a STEAM education before, and she was receiving one for the first time as part of this study. Because all participants in professional education involved in this study were female, all participants were female teachers.

Data was gathered through open tests and interviews. Using a literature review and feedback from early childhood STEAM education experts, the authors created an open-item knowledge test. Participants completed the test using a Google form. The following indicators are included in the tests:

Table 1 *Teacher Knowledge about STEAM Education*

No	Indicator	Number of Items
1.	Focus on STEAM learning in early childhood	1
2.	STEAM Learning Model for early childhood	2
3.	The benefits of STEAM learning in early childhood	5
4.	Examples of STEAM Learning in early childhood	5

Interviews were conducted with 10 teachers who got the highest score. The focus of the interview includes:

Table 2 *Teacher's Experience of STEAM Education*

No	Question Items
1.	Learning methods used in implementing STEAM learning in early childhood
2.	Learning media used in STEAM learning in early childhood
3.	Difficulties of teachers in implementing STEAM learning in early childhood

3.1 Analysis

The open test data were analyzed by comparing the average scores before and after participating in STEAM training as one of the professional education materials. The t test was used to analyze the data. The data from the interviews were coded and processed using content analysis. The codes are then classified into categories, and the number of data instances in each category is totaled. Early childhood teachers' experiences are encoded in this manner. The codes are then categorized in order to find themes.

3.2 Finding

Increasing Teacher Knowledge about STEAM Education After Participating in Teacher Professional Education.

The teachers attended training for 2 (two) weeks related to the STEAM Learning model in early childhood. Before they took part in the training, they were asked to answer questions related to teachers' knowledge of STEAM-based learning in early childhood. The percentage of teacher knowledge on pre-test and post-test on each indicator is as follows:

Table 3 *Teacher Knowledge about STEAM*

No.	Indicator	mean Pre test	mean Post tes	% Enhancement
1.	Focus on STEAM learning in early childhood	0,32	0,52	61
2.	STEAM Learning Model for early childhood	0,95	1,68	56
3.	Benefits of STEAM learning in early childhood	2,27	4,01	56
4.	Examples of STEAM Learning in early childhood	1,5	2,64	56

The table above shows that after participating in STEAM learning training for early childhood in the professional education program for in-service teachers, teachers experienced an average percentage increase in knowledge of 57.25 percent. the results of statistical tests showed a significant difference between the pre-test and post-test scores as follows:

Table 4 *Analysis Results of Paired Sample t Test on Teacher Knowledge After Attending STEAM Training*

	N	X	Sd.	*t*	*p*
Pretest	51	60, 20	12,128	25,997	,00
Posttest	51	84, 82	8, 421		

Teacher's Experience Implementing STEAM in Early Childhood in Schools

The following are examples of teachers' experiences implementing STEAM learning in early childhood education institutions:

a. Identifying the Most Effective Method

The ten teachers with the highest test scores were interviewed. They generally claim that the best STEAM learning methods are discovered through their use. It is possible that the inquiry method is appropriate for teacher A but not for teacher B, or that it is appropriate for class A children but not for class B children. According to one teacher, "I prefer to use the experimental method in STEAM learning because children can find answers to the problems studied faster." When I want to teach children about sinking, floating, and floating events, for example. Children learn more quickly if they try it right away (G. 02).

However, another teacher stated, "I prefer to use the field trip method in teaching STEAM to children." For example, if I want to teach children about the benefits of fertilizer for plants, I prefer that they see the plants that are well fertilized and those that are not in the orchard." (Genealogy 10). They admit, however, that they are still experimenting to find the best method. A teacher, for example, admitted, "...I always choose the best method by chance because I haven't found a comprehensive guide on STEAM education (G.03)."

The best method is understood by teachers not only in terms of the child's ability to absorb the material from its use, but some teachers also choose the best method based on the teacher's ability to implement it. "I am unable to use the inquiry method, so I chose the assignment method

to teach children about early mathematics, and I see the children like it and are able to complete the task." (G. 05.) "Because I can't sing or play musical instruments well, I can't use hands-on practice when teaching music, so I use the concert-going method to develop children's musical abilities." (G.03). "I am also unable to teach STEAM to children using a scientific approach, but I chose an art show to teach STEAM to early childhood because I can be the game's mastermind." (G.06). The best method was discovered by the teacher after considering the children's ability to absorb STEAM learning as well as their ability to apply the method.

b. Using the Environment as a Media

STEAM learning media can also be a fun experience for teachers. STEAM learning policies in schools are not always accompanied by media that supports their implementation. As a medium, teachers always choose media that can be easily obtained from the natural surroundings. Some professors stated the following:

"...used items like boxes, paper, bottles, and other non-organic waste can be used as STEAM learning media... (G. 09)

"... around the school, leaves, grass, and trees can be used as STEAM learning media" (G.05).

"...When the children want to teach the process of plant development, I always ask them to bring some green beans or corn.. (G.07)

"...Because our school is close to a market, we once took the children there to shop so that they could recognize different objects and understand the meaning of money as a means of payment..." (G.08). Teachers, on the other hand, hope that schools will provide STEAM learning media. One teacher, for example, stated, "...if the media is available, the teacher does not spend time looking for suitable media for STEAM learning (G. 09)."

c. Participate in Learning

The difficulty that teachers always face in STEAM learning is a lack of knowledge about various aspects of STEAM. "...I don't know much about art, which is why I always ask other teachers for help if I want to integrate art into STEAM learning (G.03)," one teacher said. Another teacher stated, "...in our school, STEAM learning is carried out with a team of teachers in order to overcome difficulties in mastering the material (G.10)." Another teacher stated, "Initially, I was concerned that I would be unable to carry out the STEAM model of learning because the content was very broad and I had never heard of it prior to attending this professional education, but the principal gave us confidence that if we worked together, we would be able..." (G.06).

Collaboration occurs not only with teachers in the classroom, but also with experts who are not teachers. One teacher narrates:...because the school wants to implement STEAM learning, we are given the opportunity to work with students from universities that collaborate with schools' mathematics education, science education, engineering education, and arts education study programs. Collaboration in the form of Field Work Practices, allowing teachers to gain experience in early mathematics, science, engineering, and art (G. 02).

Bringing in speakers in learning also contributes to collaboration in learning. "...once school invited a civil engineer on the theme of the house, when the children wanted to be introduced to how the process of building a house was..." said one teacher (G. 10). Collaboration with experts, in the teacher's opinion, can be a solution but can also cause problems. "...the children are always less able to understand the explanations of the experts, because they don't convey it in a language that the child understands," one teacher observed (G. 01).

3.3 Discuss

This study looks into the knowledge and experience of Indonesian elementary school teachers when it comes to STEAM education. The findings revealed that teachers who participated in STEAM learning training in teacher professional education gained knowledge and experience in STEAM learning. They understand that STEAM education must be conducted across disciplines and with a scientific approach. They also understand that STEAM education is beneficial for early childhood development because it encourages children to be curious, to become accustomed to using the objects around them in daily life, to improve children's scientific literacy, to teach

children to appreciate beauty, to train scientific thinking, and to practice the courage to ask questions.

Training is essential in preparing teachers to carry out their responsibilities in the classroom, because it can lead to positive attitudes toward STEAM learning (Dejarnette, 2018). Although short-term training is not always effective at transferring knowledge and skills, STEAM training for early childhood education teachers who meet the criteria has a comprehensive process for transferring professional knowledge that includes awareness, acquisition, transformation, association, application, and externalization, which can encourage teachers to implement STEAM activities in their classrooms (Liyanage et al., 2009). Because teacher professional education is based on the Liyanage model, teachers who have participated in the training have demonstrated a significant increase in knowledge.

Teachers admit that they still have limited knowledge about the right method for implementing STEAM education, so they always find the right method by chance. This is because teachers still do not have a clear picture of how STEAM integration can be realized at the early childhood education level. Furthermore, early childhood education teachers receive less training in the five STEAM disciplines than elementary, middle, or high school teachers (Aldemir & Kermani, 2017). This issue is becoming more prevalent in Indonesia, where the majority of early childhood education administrators place a greater emphasis on pre-literacy and numeracy than scientific literacy (Kartini & Widodo, 2020).

Although STEAM learning media is not available in Indonesian schools implementing STEAM education, teachers are not at a loss for solutions. They make use of the objects around them as learning aids (Siti Wahyuningsih et al., 2020). Teachers in Indonesia have followed in the footsteps of teachers in Europe who have used objects found around their children as STEAM learning media (Haughey & Hill, 2018). The use of secondhand goods as learning media can also help children develop creative attitudes toward environmental issues (Wan et al., 2021). Early childhood creativity emerges as a result of STEAM learning, which encourages them to create something new from objects around them rather than being associated with books (Wan et al., 2021). Although early childhood teachers in this study hoped that schools would provide learning media so that teachers would not have to spend time thinking about learning media and children would not be bored with less varied learning media.

Due to their limited knowledge of the content in the five disciplines, the teachers in this study recognized the importance of collaboration in STEAM learning. Some schools have collaborated with universities, and some teachers have formed partnerships with other teachers. There are even schools that form partnerships with practitioners who are experts in their fields. Aside from teacher complaints about collaboration with experts who are practitioners who sometimes convey information that is contrary to children's language skills, the ability to collaborate is critical in an effort to improve teachers' ability to carry out their duties (Stayton, 2015). Good collaboration, on the other hand, must be founded on trust, flexibility, respectful interaction, effective communication, joint planning time, and technological integration (Gonzalez, Michelle; Fryer, 2014).

CONCLUSION

Participating in programed training with regard to training requirements that can transfer professional knowledge can significantly increase the knowledge of childhood education teachers about STEAM education. Increasing professional knowledge can be a provision for childhood education teachers to gain experience in conducting STEAM education by being creative in finding the right method, providing affordable learning media, and adjusting to collaborating with teachers, prospective teachers, or practitioners. However, several issues must be addressed further, including the continuous evaluation of teachers' readiness to deliver STEAM education, teachers' confidence in collaborating with practitioners, and school readiness in providing STEAM learning facilities in early childhood education institutions.

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