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EXPLORING EARLY CHILDHOOD EDUCATION TEACHER'S BELIEFS ABOUT STEAM LEARNING IN INDONESIA

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ABSTRACT

In Indonesia, attention is being directed toward developing early childhood education (ECE), especially with innovative learning approaches such as STEAM (Science, Technology, Engineering, Arts, and Mathematics). The integrated STEAM concept can enrich children's experiences and help children overcome everyday problems. This study explores early childhood education teachers' perceptions of efforts to promote STEAM learning in the classroom and explores the challenges teachers experience in the application of STEAM learning. This study is descriptive research by using purposive sampling. Quantitative research methods were used for data collection, analysis, and interpretation, involving 117 early childhood education teachers. The results show that teachers feel comfortable talking about STEAM learning methods. On the other hand, teachers do not have sufficient knowledge to teach STEAM and critical thinking in early childhood. Furthermore, teachers do not understand enough about measurement in STEAM learning. It is reflected in several items that show that teachers need a lot of time to prepare for STEAM learning, do not have enough time in a day to teach STEAM, and do not have enough materials to do STEAM learning, inadequate availability of resources, and lack of early childhood education teacher training in STEAM. These findings support the need for teacher professional development practices to improve teachers' understanding of the importance of STEAM and the practice of teaching STEAM to young children.

Keywords: STEAM, Teacher Professionalism, Early Childhood

INTRODUCTION

Background of the Study

STEAM education has become a global trend in improving children's abilities in various fields. In Indonesia, early childhood education (ECE) has become one of the important educational institutions for developing early childhood skills. ECE teachers have an important role in developing children's abilities through various methods and strategies. Therefore, ECE teachers' belief in STEAM is very important in improving the quality of education.

Early childhood education ECE plays an important role in forming the basis of children's knowledge, skills, and attitudes. In Indonesia, attention to ECE development is increasing, especially with the implementation of innovative learning approaches such as STEAM (Science, Technology, Engineering, Arts, and Mathematics). The STEAM approach aims to integrate various disciplines in a holistic and interdisciplinary way, to foster critical and creative thinking skills. However, the successful implementation of STEAM relies heavily on teachers' beliefs and understanding of this approach.

The Indonesian Ministry of Education, Culture, Research and Technology has incorporated the basics of Literacy and STEAM into the latest Merdeka Curriculum (2022). This approach is again developed in developed countries, one of which is the STEAM approach (Munawar et al., 2019). STEAM learning is learning that can combine several disciplines. STEAM is not only popular at the higher education level which emphasizes the development of higher-order thinking skills (HOT), it has even been introduced at the primary school level (Nasrah et al., 2021).

STEAM learning can be defined as learning that integrates the skills that children need. The term STEAM comes from STEM which encourages children to observe, investigate, and ask questions about the world around them (AtaAktürk, Demircan, Şenyurt, & Çetin, 2017). STEM is considered to provide beneficial learning for children. By adding "art" to the STEAM acronym, children will have the opportunity to demonstrate STEM concepts creatively and imaginatively (Radziwill, Benton, & Moellers, 2015). STEAM for early childhood aims to enhance creativity and problem-solving skills (Yalçın & Erden, 2021).

Promoting STEAM education is a desirable goal for almost all societies. Many countries are paying attention to STEAM. Canada and Australia see STEAM education positively and recognise that ‘artistic design and creativity is an important foundation of successful mathematicians, scientists and engineers’ (Quigley & Herro, 2016). This is an important part of increasing student participation and encouragement. Norway has been developing a strategic plan known as ‘STEM of Course’ since 2002. The aim of the programme is to improve STEM teaching skills for teachers at all levels of education, from early childhood to secondary education (Çiftçi et al., 2022). In line with China, China has paid great attention to science education and stated that science is essential for a developed society. Science teaching in Chinese has a special characteristic system. In middle school, biology, chemistry and maths should be studied together with STEM education. In high school, STEM education has been added. The trend of STEM has accelerated in the past six years. The curriculum for grades 10-12 has been updated and STEM subjects have been incorporated into teacher training programmes (STEM_Education_Report, n.d.).

The United States and Korea want to increase students' interest, engagement, motivation and value in STEM education through STEAM education (So et al., 2019). The overall goal is the same: train students to become world leaders in science and technology by fostering interest and deeper understanding through arts integration, ‘experiential and inquiry-based approaches’ (So et al., 2019). STEAM education began being promoted in Korea to foster students' interests and self-efficacy in science and mathematics and to improve and enhance their academic achievements, creativity, and problem-solving skills (Stewart et al., 2019). The United States needs more talented engineers and scientists. Therefore, efforts are being made to engage children at an early age in STEM (DeJarnette,

2018). In 2013, Barack Obama said, 'We don't want our kids to be just consumers of the amazing things that science produces; we want them to be producers too' (Çiftçi et al., 2022).

Early childhood teachers play an important role in encouraging children's interest and engagement in STEAM learning. Therefore, teachers' disciplinary backgrounds, hands-on experiences, playing while learning with children, and habits of mind are important to support the application of STEM in supporting: (a) planning integrated STEM learning experiences; and (b) more holistic understanding and language exchange among early childhood educators, parents, and children (Simoncini et al, 2018). In addition, research Wahyuni et al., (2020) shows that teachers act as facilitators in STEAM learning methods, and children are at the core of the learning process, both inside and outside the classroom.

Problem Statement

The results of the 2018 PISA assessment show that Indonesia is still below the average PISA level and is ranked 72 out of 77 countries participating in the PISA test (OECD, 2019). This gap can occur due to students' lack of knowledge, especially in the fields of science literacy, language literacy, and math literacy. Today's children are faced with drastic changes. Starting from the rapid development of technology that changes human relationships, the increasing variety of social media that affects child development, not to mention the increasing social problems that occur around.

The challenges faced by teachers and students in adopting the STEAM approach vary. (Ng et al., 2022) explain that there are several challenges to integrating STEAM into ECE from the perspective of accessibility to resources, availability of supports and trainings, the role of ECE teachers, and implementation and translation of pedagogy into practice. In implementing STEAM, teachers still face problems related to accessibility of age-appropriate materials, accommodating learners with special needs, lack of sequencing of curriculum units, and lack of time (John et al., 2018).

The PAUD curriculum in Indonesia has undergone changes, the 2021 "Merdeka" Curriculum has included content related to literacy and STEAM in the latest curriculum. Since the implementation of the Merdeka Curriculum, it turns out that not many teachers have optimally implemented STEAM in their learning at school (Education et al., n.d.). STEAM is a new approach that teachers must master. The Ministry of Education and Culture only provides teacher guidebooks related to learning the basic elements of literacy and STEAM. Therefore, this research is important to understand how early childhood teachers perceive STEAM and what challenges teachers face in its application

Although many studies have addressed STEAM implementation in various countries, there are still few studies that specifically explore the perceptions and challenges faced by ECE teachers in Indonesia in implementing STEAM. Therefore, this study aims to fill this gap by examining how early childhood teachers in Indonesia perceive STEAM learning and understand the challenges in implementing STEAM in learning. This study seeks to address these gaps by exploring two key questions:

1. How do teachers perceive STEAM learning?
2. What are the challenges teachers experience in implementing STEAM learning?

METHODOLOGY

This study used a quantitative approach with a survey method. This study was conducted by involving a sample of 117 preschool teachers in Lampung, Indonesia who have STEAM teaching experience. The selection of kindergarten teachers as a sample is because according to Fraenkel and Wallen (1996), if the research uses homogeneous purposive sampling, a small sample is sufficient. This is consistent with Cresswell et al. (2011) who state that sample involvement is necessary because the sample is selected based on individuals or groups who have the ability and knowledge relevant to the research objectives. Data were collected through a survey by distributing questionnaires to kindergarten teachers. The questionnaire as an instrument used a Likert scale ranging from 1 = strongly disagree, 2 = disagree, 3 = less agree, 4 = moderately agree, 5 = agree, and 6 = strongly agree, respondents indicated the level of agreement or disagreement with the statement. The questionnaire consisted of 15 items related to teacher comfort with STEAM learning and 11 items related to teacher challenge in STEAM learning, so a total of 26 items were given to teachers.

In this study, this questionnaire is a modification of previous research conducted by studying the articles "ECE Teachers' Beliefs about Readiness to Teach Science, Technology, Engineering, and Mathematics (2017)", and "Implementation of STEAM in Early Childhood Classrooms (2018)" which was then modified by the researcher in several parts which were then referred to with professional judgment according to the needs and suitability of the objectives of this study. An instrument reliability of 0.908 was obtained, which indicates a high level of internal consistency of the instrument. All data obtained from the questionnaires were analyzed using Statistical Package for Social Science (SPSS) Version 27.0 software. In this study, descriptive statistics and inferential statistics were used to analyze the data and answer the research questions and hypotheses developed.

RESULTS AND DISCUSSIONS

Respondent Profile Analysis

Analysis of respondent profiles according to aspects of gender, age, teaching experience, classroom teacher, academic qualifications, and PPG (Teacher Professional Education Program) teacher certificates. The results obtained data from 117 early childhood education teachers in Indonesia. The following is the distribution of respondent data in Table 1:

Table 1

Respondent Profile Analysis

Category	Frequency	Percentage (%)
Gender		
Male	5	4.3
Women	112	95.7
Age		
20-30 years old	64	54.7

continued

31-40 years old		25	21.4
41-50 years old		20	17.1
51-60 years old	8		6.8
Work Experience			
0-5 years		65	55.6
6-10 years		19	16.2
11-15 years		11	9.4
16-20 years		13	11.1
21-25 years old	9		7.7
Class teacher			
Playgroup		28	23.9
Kindergarten a		45	38.5
Kindergarten b		44	37.6
Academic Eligibility			
High School		12	10.3
Bachelor in ECE		74	63.2
Bachelor's in education		12	10.3
Bachelor non-education		11	9.4
Master's in education	8		6.8
PPG Education			
Already		31	26.5
Yet		86	73.5
Total		117	100

Based on the data, several categories of study of the respondents were obtained. First, most respondents in this study were ECE teachers, consisting of 5 men (4.3%) and 112 women (95.7%) of the sample size. There were more female teachers than male teachers. Second, the age level of the respondents involved in this study. Based on the age category, most respondents selected were in the age range of 20-30 years, namely 64 people (54.7%), followed by the age range of 31-40 years as many as 25 people (21.4%), then 41-50 years of age as many as 20 people (17.1%) and 51-60 years of age as many as 8 people (6.8%). This shows that the age group of respondents who are in the age group of 20-30 years, which means young teachers.

Third, the category of respondents' work experience. More than half of the teachers with 0-5 years of experience worked with as many as 65 people (55.6%). Followed by 19 people (16.2%) with work experience of 6-10 years. Furthermore, 13 people (11.1%) with work experience of 16-20 years, 11 people (9.4%) with work experience of 11-15 years, and 9 people (7.7%) with work experience of 21-25 years. This shows that teachers have good teaching experience.

Fourth, class teachers consisted of 45 (38.5%) Kindergarten A class teachers, followed by 44 (37.6%) Kindergarten B class teachers and 28 (23.9%) Playgroup teachers. The sixth is the academic qualifications of the respondents. Respondents consisted of teachers who had high school diploma eligibility up to doctoral diploma. A total of 74 people (63.2%) has a Bachelor in ECE certificate, followed by 12 people (10.3%) with a bachelor's

in education, 12 people (10.3%) with a Senior High School certificate, 11 people (9.4%) with a Bachelor non-education and finally there are 8 people (6.8%) with master's in education. The last category is Preservice teacher education, it was found that 86 teachers (73.5%) have not implemented PPG, and 31 teachers (26.5%) have participated in PPG. This means that there are fewer teachers with professional certificates than those who have implemented PPG.

Teacher Comfort with STEAM learning

The results of the teacher perception questionnaire on the convenience of STEAM learning in general are presented in Table 2 below

Table 2

Teacher Comfort in STEAM Learning

Teacher Confort Items	Strongly disagree	Disagree	Less agree	Moderately agree	Agree	Strongly agree	Median
	(%)	(%)	(%)	(%)	(%)	(%)	
1. Feel comfortable doing STEAM activities	4.3	5.1	5.1	11.1	55.6	18.8	5.00
2. Collecting materials. objects for science learning	5.1	4.3	0.9	10.3	54.7	24.8	5.00
3. Planning/demonstrating STEAM learning comfortably	5.1	5.1	0	13.7	46.2	29.9	5.00
4. Use all types of materials for STEAM activities	6.0	4.3	3.4	23.9	41.9	20.5	5.00
5. Implement STEAM elements in learning throughout the week	5.1	5.1	14.5	25.6	38.5	11.1	4.00
6. Enjoys doing STEAM activities	6.8	3.4	3.4	14.5	49.6	22.2	5.00
7. Planning/demonstrating STEAM with daily life comfortably	6.8	3.4	2.6	14.5	47.9	24.8	5.00

continued

8. Using books as a source to get ideas	5.1	5.1	8.5	19.7	43.6	17.9	5.00
9. Using science books when telling stories	6.0	4.3	6.0	25.6	42.7	15.4	5.00
10. Feels comfortable with physical/energy science	6.8	3.4	7.7	16.2	52.1	13.7	5.00
11. Discussing ideas and problems with other teachers	6.0	4.3	1.7	11.1	35.0	41.9	5.00
12. Demonstrating experimental procedures	5.1	5.1	0.9	12.0	49.6	27.4	5.00
13. Utilizing the Internet to get ideas	5.1	5.1	0.9	6.0	36.8	46.2	5.00
14. Got ideas from what was done, said, and asked by the children.	5.1	5.1	2.6	14.5	45.3	27.4	5.00
15. Using STEAM resources to help plan lessons	5.1	5.1	1.7	14.5	48.7	24.8	5.00

Table 2 explains teacher comfort in STEAM learning in the classroom. 15 statement items have been analyzed. The first item, teachers feel comfortable doing STEAM activities showed (55.6%) agreed with the item and as many as (4.3%) of the sample strongly disagreed. The median value for this item is 5.00. For the second item, teachers collect materials. objects for science learning showed that (54.7%) agreed with the item and as many as (0.9%) disagreed. The median value for this item is 5.00.

For the third item, teachers in Planning/demonstrating STEAM learning comfortably showed that (46.2%) agreed with the item and as many as (0%) disagreed. The median score for this item is 5.00. For the fourth item, teachers using all types of materials for STEAM activities showed that (41.9%) agreed with the item and as many as (3.4%) disagreed. The median score for this item is 5.00.

For the fifth item, teachers implementing STEAM elements in lessons throughout the week showed that (38.5%) agreed with the item and as many as (5.1%) disagreed and strongly disagreed. The median value for this item is 4.00. For the sixth item, teachers who enjoy doing STEAM activities showed that (49.6%) agreed with the item and as many as (3.4%) disagreed and disagreed. The median value for this item is 5.00. For item seven,

teachers planning/demonstrating STEAM comfortably showed that (47.9%) agreed with the item and as many as (2.6%) disagreed. The median value for this item is 5.00. For item eight, Teachers use books as a source to get ideas showing that (43.6%) agree with the item and as many as (5.1%) disagree and strongly disagree. The median value for this item is 5.00. For the ninth item, teachers using science books when telling stories showed that (42.7%) agreed with the item and as many as (4.3%) disagreed. The median value for this item is 5.00. For the tenth item, teachers feel comfortable with physical science/energy shows that (52.1%) agree with the item and as many as (3.4%) disagree. The median value for this item is 5.00. For the eleventh item, teachers discussing ideas and problems with other teachers showed that (41.9%) strongly agreed with the item and as many as (1.7%) disagreed. The median value for this item is 5.00. For the twelfth item, the teacher demonstrates the experimental procedure in showing that (49.6%) agree with the item and as many as (0.9%) disagree. The median value for this item is 5.00.

For the thirteenth item, teachers utilizing the internet to get ideas, it shows that (46.2%) strongly agree with the item and as many as (0.9%) disagree. The median value for this item is 5.00. For the fourteenth item, teachers get ideas from what children do, say, and ask showing that (45.3%) agree with the item and as many as (2.6%) disagree. The median score for this item was 5.00. For the last item, teachers using STEAM resources to help plan lessons showed that (45.3%) agreed with the item and as many as (2.6%) disagreed. The median score for this item is 5.00. Most of the ECD teachers surveyed demonstrated a basic understanding of the STEAM concept. They understand that STEAM is an approach that integrates science, technology, engineering, art, and math to create a well-rounded learning experience. However, there is variation in the depth of understanding, especially in how each discipline can be practically integrated into daily classroom activities.

Teacher Challenge

The results of the questionnaire on challenges that teachers face in learning STEAM to early childhood, in general, are presented in Table 3 below:

Table 3

Teachers Challenge in STEAM Learning

Teacher Challenge Items	strongly disagree (%)	disagree (%)	less agree (%)	moderately agree (%)	agree (%)	strongly agree (%)	Median
1. Not having enough knowledge to teach STEAM	2.6	13.7	21.4	25.6	27.4	9.4	3.00
2. Not comfortable talking about STEAM learning methods.	2.6	6.8	8.5	44.4	30.8	6.8	3.00

continued

3. Do not understand enough about measurement in STEAM learning	0.9	10.3	18.8	37.6	24.8	7.7	3.00
4. Not having enough knowledge about critical thinking in early childhood	1.7	8.5	17.9	30.8	32.5	8.5	3.00
5. Fear of children asking questions that are difficult to answer.	0.9	8.5	12.0	29.1	35.0	14.5	3.00
6. Not enough time in a day to teach STEAM.	3.4	22.2	20.5	22.2	24.8	6.8	3.00
7. Takes a lot of time to prepare for STEAM learning.	6.8	25.6	19.7	19.7	19.7	8.5	4.00
8. Planning/demonstrating STEAM learning is difficult.	1.7	10.3	17.9	30.8	26.5	12.8	3.00
9. Not having enough materials to do STEAM learning	2.6	8.5	25.6	25.6	24.8	12.8	3.00
10. Lack of availability of resources	3.4	11.1	29.1	21.4	23.9	11.1	3.00
11. Lack of teacher training in STEAM	12.0	30.8	22.2	14.5	14.5	6.0	4.00

Table 3 explains the challenges teachers face in implementing STEAM learning. 11 statement items have been analyzed. The first item, teachers do not have enough knowledge to teach STEAM shows (27.4%) agree with the item and as many as (2.6%) samples strongly disagree. The median value for this item was 3.00. For the second item, not comfortable talking about STEAM learning methods shows that (44.4%) moderately agree with the item and as many as (2.6%) strongly disagree. The median value for this item is 3.00.

For the third item, the challenge item teachers do not understand enough about measurement in STEAM learning showed that (37.6%) moderately agreed with the item and as many as (0.9%) strongly disagreed. The median score for this item was 3.00. For the fourth item, not having enough knowledge related to critical thinking in early childhood shows that (32.5%) agree with the item and as many as (1.7%) strongly disagree. The median value for this item is 3.00. The fifth item is the fear of children asking questions that are difficult to answer shows that (35.0%) agree with the item and as many as (0.9%) strongly disagree. The median value for this item is 4.00.

For the sixth item, not enough time in the day to teach STEAM, it shows that (24.8%) agreed with the item and as many as (3.4%) strongly disagreed. The median score for this item is 3.00. For item seven, it takes a lot of time to prepare for STEAM learning shows that

(25.6%) disagree with the item and as many as (6.8%) strongly disagree. The median score for this item is 4.00. For item eight, Planning/demonstrating STEAM learning is difficult shows that (30.8%) moderately agree with the item and as many as (1.7%) strongly disagree. The median score for this item was 3.00.

For the ninth item, not having enough materials to conduct STEAM learning showed that (25.6%) moderately agreed and less agree with the same results of the item and as many as (2.6%) strongly disagreed. The median score for this item was 3.00. For the tenth item, insufficient resource availability shows that (29.1%) less agree with the item and as many as (3.4%) strongly disagree. The median score for this item was 3.00. Furthermore, the last item, insufficient teacher training in STEAM showed that (30.8%) disagreed with the item and as many as (6.0%) strongly agreed. The median value for this item is 4.00.

DISCUSSION AND IMPLICATIONS

Based on the results of the questionnaire given to ECE teachers, it shows that teachers feel comfortable doing STEAM activities. Teachers enjoy doing STEAM activities. Also feel comfortable learning science related to physical/energy. This can be seen in the teacher's agreement in carrying out STEAM learning starting from planning/demonstrating STEAM learning comfortably including, collecting object materials for science learning, using all types of materials for STEAM activities, and linking them to everyday life.

Teachers came up with some different ways of STEAM learning for early childhood. These ideas include books as a source get ideas such as science books when telling stories, discussing ideas and problems with other teachers, demonstrating experimental procedures, utilizing the internet to get ideas, getting ideas from what children do, say, and ask, and using STEAM resources to help plan lessons. The use of information and communication technology (ICT) will facilitate the teacher as a teaching aid (Nordin & Bacotang, 2021). Teachers utilize the media and objects around them as learning aids such as loose parts around them (Wahyuningsih et al., 2020).

Learning with loose parts media can provide freedom to play and learn so that it can build independent early childhood learning (Purwanti, 2023). The teacher's strategy is to use loose teachers to arrange a comfortable play environment for children. Teachers can easily use loose parts learning to provide various learning resources for children in our surrounding environment. These items usually consist of seven parts: natural materials, wood, plastic, metal, ceramic, factory, and packaging (Siantajani, 2018). In line with (Ghazali & Yusuf, 2022) which supports that the method of learning while playing or game-based learning is more interesting for learning STEAM activities.

In STEAM learning challenges, teachers experience several challenges in STEAM learning to encourage critical thinking skills in early childhood, including Not having enough knowledge to teach STEAM and critical thinking in early childhood. Teachers do not understand enough about measurement in STEAM learning. This will have an impact on the process of planning and implementing learning. It is reflected in several items that show that teachers need a lot of time to prepare for STEAM learning, do not have enough time in a day to teach STEAM, and do not have enough materials to do STEAM learning. This is in line with the problems that occur when implementing STEAM in ECE that teachers do not understand how STEAM concepts should be integrated into their learning (Faiz et al., 2021). As a result,

there is a lack of facilities that support the STEAM concept in ECE (Astuti, 2021). To meet the needs of the 21st century, teachers must change. Developing critical thinking skills in the classroom faces challenges, including a lack of knowledge about critical thinking, teachers' inability to assess students' ability to think critically, and a lack of resources (Khalid et al., 2021).

Furthermore, significant data was obtained that teacher training in the field of STEAM is lacking, which will indirectly affect the availability of resources. Given this, training is needed for early childhood teachers on how to plan, implement, and evaluate STEAM learning. Early childhood teachers need pre-service and in-service training to learn more about how to develop STEAM content knowledge and practices and how to implement STEAM education in the learning environment (Soylu, 2016). Teachers need intensive training to implement STEAM learning (Sawangmek, 2019); Wan et al., 2021) but unfortunately many teachers admit that they do not understand the integration of STEAM in learning, yet they have a positive view of the learning model (Kartal & Taşdemir, 2021). According to (Abd. Halim et al., 2023) the importance of increasing knowledge and maintaining high interest and positive attitudes of teachers by implementation of various efforts in preschools such as collaborative and technical support, as well as recognizing the role of the of preschool teachers in the implementation of STEM education.

The interesting thing obtained is that when teachers provide answers related to comfort in the implementation of STEAM, it is inversely proportional to the challenges felt by teachers. In the comfort item, it is stated that teachers are comfortable doing STEAM learning activities but in the challenge item, it is found that teachers are not comfortable talking about STEAM learning methods. Educators who know about STEAM learning are needed. Teachers who have extensive knowledge of their subjects will be better equipped to help their students learn (Parkay & Stanford, 2010). Teachers should always try their best to improve their knowledge and insight. Teachers should also always learn to improve themselves (Naim, 2016).

The implication of this finding is the need for intensive and continuous training for early childhood teachers in planning, implementing and evaluating learning. Teachers need to understand STEAM integration and develop critical thinking skills in early childhood. Increasing teachers' capacity in STEAM is essential to improve the effectiveness of learning in ealy childhood education. This includes not only technical training but also a paradigm shifts in education so that teachers are more confident in implementing a holistic STEAM approach, based on developing critical thinking skills in the 21st century.

CONCLUSIONS

This study shows that early childhood teachers in Indonesia have positive beliefs about the benefits of STEAM in early childhood education. However, there are significant challenges that need to be overcome to effectively implement STEAM. Results show that teachers feel comfortable talking about STEAM learning methods. On the other hand, teachers do not have sufficient knowledge to teach STEAM and critical thinking in early childhood. Furthermore, teachers do not understand enough about measurement in STEAM learning. It is reflected in several items that show that teachers need a lot of time to prepare for STEAM learning, do not have enough time in a day to teach STEAM, does not have enough materials to do STEAM learning, inadequate availability of resources, and lack of early childhood education teacher training in STEAM.

Suggestion:
By doing these things, it is hoped that STEAM education can become an important part of early childhood education (ECE) in Indonesia. This will prepare the younger generation with the necessary skills and knowledge for an increasingly complex and high-tech future.

1) Create a special training program that focuses on the application of STEAM in the context of ECE, involving both theory and hands-on practice.
2) Increase the availability of educational resources and tools that support STEAM activities in the classroom
3) Build collaborative networks between teachers, schools, and communities to share best practices and experiences in STEAM implementation.

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

AUTHOR CONTRIBUTIONS

The author conceived and designed the study, collected data, performed data analysis, and wrote the manuscript. The corresponding author acted as an academic advisor, providing constructive feedback and guidance to improve the content and quality of the manuscript.

DECLARATION OF GENERATIVE AI USE

No generative artificial intelligence (AI) tools were used in the design, data collection, analysis, interpretation of the findings, or writing of this manuscript.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access to the data may be subject to ethical considerations and the intended purpose of use.

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