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Enhancing Early Childhood Educator Proficiency in Implementing STEAM-Loose Parts using a Project-based Learning Model

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ABSTRACT:
Applying STEAM-based learning methods is challenging for early childhood (EC) educators because most of them need help to develop media and learning activities. This study aims to improve EC teachers' proficiency in implementing STEAM learning methods with loose-part materials through project-based learning (PjBL) models. This action research uses the Elliot model, which consists of 7 steps: initial idea identification, fact analysis, general planning, implementation, observation, evaluation, and idea improvement. The participants in this study were 15 preschool teachers from different institutions in Langsa, Aceh. Data collection techniques used observation and the instruments consisted of observation sheets and project assessment sheets. The results showed that the average score of teacher competence in cycles one and two increased. 80% of the total 15 teachers have reached the minimum success indicator. Therefore, the PjBL method is concluded to improve the competence of EC teachers in implementing STEAM method learning with loose parts. From the results of this study, it is hoped that teachers can apply it in their respective institutions to provide more comprehensive benefits to students. This study suggests that early childhood institutions should help EC teachers implement the STEAM-based loose parts. Further research can be conducted in ECE on the extend of STEAM implementation.

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1. Introduction

The implementation of science, technology, engineering, art, and mathematics (STEAM) based learning methods is a challenge that must be faced by educators, including early childhood educators, to develop 21st-century skills: critical thinking, communication, collaboration, creativity, and technology mastery skills (Leung, 2023; Munawar et al., 2019; Peppler, 2017). STEAM is an overgrowing learning method that utilizes science, technology, engineering, art, and mathematics in an integrated, student-centered manner. STEAM has been developed in various countries, from the pre-school to the post-doctoral levels, both formal and informal education (Cheng, 2022; Gonzalez & Kuenzi, 2014).

STEAM learning can be integrated into the 2013 Early Childhood Education (ECE) curriculum with integrative thematics and a scientific approach. This learning is close to children, and the material raised is under everyday life (Asmar & Hasnawati, 2019; Conradty & Bogner, 2020). STEAM focuses on understanding the integrated nature of multiple disciplines, long-term academic success, economic well-being, (Herro & Quigley, 2016), and community development (Han, Sun & Rosli, Roslinda & Capraro, Mary & Capraro, 2019). STEAM education is also recognized in the United States as an educational reform described as an instructional approach to preparing children for the global economy of this century (Yakman & Lee, 2012).

In STEAM learning, ECE teachers must develop high-level skills, critical thinking, and detailed open-ended questions that children can understand. Teachers must also change the traditional learning process to be child-centered so that children can communicate their creations based on the designs they develop. Therefore, preschool institutions and teachers play an essential role in this regard. Teachers' understanding of school readiness also affects how teachers build children's readiness (Syarfina et al., 2018). Early childhood is a golden period, so teachers should create a program appropriate to the early childhood development (Aisyah et al., 2021; Hidayat & Nur, 2018). Therefore, preschool teachers must have pedagogic competence in implementing interesting and fun STEAM learning methods.

However, although the government has socialized STEAM learning in Indonesia to representatives of ECE teachers by the Directorate of Early Childhood Teachers and Education Personnel (PPPPTK & PLB, 2020), most ECE teachers still need to implement STEAM-based learning methods in their institutions. The term STEAM is also unfamiliar to some educators. Teachers still need clarification to apply it to preschool children. In addition to the lack of teacher competence in implementing the STEAM learning method, teachers find it difficult and unprepared to teach because they feel the lack of media and technological resources in implementing STEAM learning. Teachers think STEAM is impractical, even though some loose parts materials can be used as STEAM learning materials that support children's creativity and imagination and can develop children's ideas in fun. Loose parts materials can be in the form of natural materials or used goods, which are quite efficient because of minimal costs.

Research on the implementation of STEAM learning methods in early childhood has been carried out, such as the implementation of STEAM in increasing children's independence (Septiani & Kasih, 2021), children's creativity (Wahyuningsih et al., 2020), children's cooperative attitudes (Harjanty & Muzdalifah, 2022), as well as stimulation of child development in general (Tabiin, 2020). Some studies analyze SWOT (strengths, weaknesses, and opportunities) on the implementation of STEAM and inputs for adding religiosity items (Cabello et al., 2021; Hapidin et al., 2020). STEAM research has also been examined to see the extent of STEAM implementation in the health aspect of preventing disease transmission in early childhood (Syarfina et al., 2022). In addition, research examining the application of the direct STEAM method with loose part materials has also been investigated by (Oktari, 2017; Prameswari & Anik Lestariningrum, 2020; Wahyuningsih et al., 2020), but the focus of the research is on improving children's abilities. There has yet to be research on efforts to increase the competence of ECE teachers in implementing the STEAM method.

The action chosen is the project-based learning (PjBL) model by considering some of the advantages of the model and the effectiveness of the treatment that will be given to ECE teachers (Almulla, 2020; Dobson & Dobson, 2021; Lesmana & Arpan, 2017; Roessingh & Chambers, 2011). Furthermore, project-based learning is a learning strategy that allows learners, either an adult or a child, to gain new knowledge and understanding based on experience (Widyantini, 2014). The characteristics of project-based learning are that participants review essential ideas and ask questions. They gain understanding in the research process, make products and think creatively according to their needs and interests, critically and skillfully conclude material, and relate it to authentic world realities, problems, and problems. Therefore, this action research aims to increase the competence of ECE teachers in STEAM learning, especially by using loose parts materials through the PjBL model.

2. Method

This type of research is action research using a research model from Elliot, which consists of 7 steps, including initial idea identification, fact analysis, general planning, implementation, observation, evaluation, and idea improvement (Elliot, 1991). The research model from Elliot was chosen because the stages are more detailed so that the resulting actions can optimize teacher competency improvement as expected. In addition, observation and evaluation of actions in Elliot's research model are carried out in more detail on each variation of the action, which aims to find out what factors cause failure; until then, the factors that cause failure are corrected to design a new general plan. It allows researchers to improve project-based learning (PjBL) models in depth per meeting so that teachers are more enthusiastic and active and their teaching skills increase significantly.

The participants in this study were 15 ECE teachers from different ECE institutions in Langsa City. Based on the category of participant involvement, this type of action research includes district-wide action research. Many and broader benefits will be obtained from this research because it is much more complex and requires more resources.

This action research was conducted in 2 cycles: the first cycle of 3 meetings and the second cycle of 2 meetings. Researchers and collaborators collaborate in improving the action process until they are at the level of understanding according to the achievement of success. If the first cycle has yet to reach the assessment criteria, the next cycle will be carried out, a repetition of the first cycle but starting from the revised general planning stage. The design of the action research cycle, which is designed according to the Elliot model for this research includes seven stages: 1) Identification of the Initial Idea. At this stage, the researcher identified the results of the pre-cycle assessment. In addition, researchers are looking for information regarding the problems teachers face in implementing learning using the STEAM method. 2) Fact Analysis. At this stage, various information is collected by researchers about the problems that occur. The researcher analyzed the facts based on the information found by the teacher. Does it affect local culture and policies? Have early childhood ECE teachers received the information about STEAM before? Has the teacher ever had an intervention to pay attention to loose-parts? These questions were carried out to focus on research researchers and determine appropriate actions to improve teacher competence. 3) General Planning. At this stage, the researcher developed several steps for an action treatment plan to increase the understanding of early childhood teachers in STEAM learning based on loose parts according to the objectives of this study.

Data collection techniques used observation. The observation technique in this study was used to observe the learning activities of the research subjects. The observations were participant observation; in this case, the researcher observed the PjBL model learning activities in STEAM and the stages of teacher competency improvement. Performance appraisal is used for a task that requires nonverbal responses. In this study, performance appraisal is an assessment by observing the project produced by the teacher. This assessment is used to assess the development of teacher competency improvement in implementing the STEAM method made from loose parts.

The instrument used in this study consisted of an observation sheet and a project assessment sheet. Teacher activity observation sheets in STEAM learning activities using the PjBL model and project sheets in the form of scores to prepare STEAM-based on daily lesson plans create learning media made of loose parts and presentation/teaching skills. The instrument grid in this study consists of several aspects: method aspect, which includes the teacher's ability to explain each indicator of STEAM learning and design STEAM-based learning; material aspects, which include the teacher's ability to utilize loose-part materials and model children's work using loose-part materials; and the next aspect is the evaluation of the teacher's ability to explain the assessment techniques used and assess children's achievement in 6 aspects of development through STEAM learning.

3. Result And Discussion

The results showed increased teacher competence in implementing STEAM learning methods from loose parts in early childhood by using project-based learning (PjBL) and discuss sequentially based on Elliot's model stages, which consists of 7 steps: initial idea identification, fact analysis, general planning, implementation, observation, evaluation, and idea refinement.

Cycle I

Identify Initial Idea. The initial assessment results show that only eight teachers have heard of the STEAM learning method but have yet to implement it consistently in ECE. Six teachers have never heard of it, and one has attended STEAM training made from loose parts. In addition, the HIMPAUDI, a teacher professional organization, in Langsa has yet to create a special effort to improve teacher competence in implementing the STEAM learning method made from loose parts. It was the initial identification in the implementation of this action research.

Fact Analysis. According to an analysis of field facts, the factors that influence the lack of information on teachers' understanding of STEAM come from loose parts from teachers and professional organizations. The factor that comes from the teacher is that most teachers still need an early childhood education background, kindergarten education, and *Raudhatul Athfal* education. In addition, they have never attended basic ECE training, so they are still unfamiliar with the STEAM method, especially those made from loose parts. Factors originating from professional organizations are organizations that focus more on curriculum review activities, conducting workshops on accreditation preparation, and holding teacher and student competitions. Teachers have yet to receive training to improve the quality and professionalism of ECE teachers, so it impacts the quality of teaching and learning, in this case, especially the STEAM method made from loose parts. So far, ECE teachers have only been busy teaching activities and preparing administration. Although several schools have implemented ECE teacher quality improvement programs, their implementation must be more comprehensive.

Based on this analysis, the researchers tried to improve by implementing action research. The action taken is to increase the competence of ECE teachers in implementing the STEAM learning method based on loose parts by using the project-based learning (PjBL) model. This method is expected to assist ECE teachers in implementing the STEAM method made from loose parts, which impacts the quality of teaching. Preschool culture impeding creativity is essential to elicit teachers' conceptions in developing their creativity (Davies et al., 2014). This action also supports the goal of HIMPAUDI Langsa in creating professional ECE teachers to educate the Indonesian generation.

General Planning. After the facts are analyzed, the researcher designs a general plan. Collaborators are needed as partners in conducting and observing the process and results of success in research. Researchers and collaborators design the steps for PjBL activities. These steps are (1) project determination, (2) project completion steps design, (3) schedule preparation, (4) project completion, (5) project reporting and presentation, and (6) project evaluation and reflection. Researchers measure the pedagogical competence of ECE teachers in implementing STEAM learning made from loose parts, including methods, materials, and evaluation. Researchers and collaborators also determine the indicators of success used to determine the increase in teacher competence in implementing STEAM made from loose parts. Indicators of teacher pedagogical competence on STEAM by loose parts are designing STEAM-based learning, explaining indicators of STEAM learning, utilizing loose part materials, giving examples of children's work using loose part materials, assessing children's achievements of development aspects through STEAM learning, describing the assessment technique used. The indicator is set with a score of at least 80% after the action. Data collection tools were prepared as field notes, observation sheets, and performance results sheets to obtain maximum results.

Implementation. In the first cycle of the first meeting, researchers and participants discussed the STEAM learning method and loose part materials to enrich the teacher's ideas in determining projects and designing learning media from loose parts materials. Then, the research team provided loose parts such as natural materials or used materials such as various seeds, dry leaves, rocks, dry twigs, various beads, various buttons, various threads, seashells, various papers, various spices, various used bottles, plasticine, various toy animals, cotton, various ice cream sticks, drinking straws, and others. Loose parts media is a natural material-based media which, according to Yukananda (Oktari, 2017), is called so because it comes from the environment and is intentionally processed and used to support learning activities. Natural materials such as stones, wood, twigs, seeds, dry leaves, banana stems, and bamboo are considered relevant for the safety of children. The consideration is also quite efficient because it does not have a cost. Use and collect these materials from the natural environment and can also reduce waste by turning unused materials into meaningful materials. This theory was first developed by Nicholson in 1971 and allowed children to express their creativity through materials that they can modify, change, and make themselves (Gull et al., 2019).

After having a discussion, the researcher determines the theme for STEAM-based learning, namely the "Animals" theme, and then the researcher frees the teacher to determine the sub-themes of the "animals" theme. Some choose the theme of pets, wild animals, farm animals, sea animals, and others. After that, the teacher prepares scenarios for STEAM learning activities in the form of lesson plan, in which there is also a design of learning media from loose parts materials.

After the teacher determines the sub-themes and arranges learning activities, the teachers are directed to choose loose parts of natural and used materials provided by the research team. Next, the teachers make learning media from loose parts. After the learning media project is completed from loose parts, the teacher presents it to the other participants. This activity was carried out to train the teachers to present their work by designing and making learning media from loose parts. In this activity, the teachers gave each other feedback for future improvements. The results of the teacher's creation in the first cycle of the first meeting include bee-drawing patterns from dry leaves, bee-drawing patterns from seeds, hedgehog shapes from plasticine and matchsticks, fish from seeds, sheep and their food, sheep drums, and the like.

In the first cycle of the second meeting, the researcher determined the theme "environment" for STEAM-based learning. Then, the researcher freed the teacher to determine the sub-theme of the "Environment" theme. Some choose the theme of the house, school, garbage, family, mosque, place of worship, traditional house, and others. Afterward, the researcher and participants discussed STEAM; the teacher prepared scenarios for STEAM activities in lesson plan and designed learning media from loose parts. After the teacher determines the sub-themes and designs the media to be made, the teachers are directed back to choosing loose parts of natural materials and used materials that the researcher has provided. Next, the teachers make learning media from loose parts.

After creating learning media from loose parts, the teacher did micro-teaching in front of the other participants. This activity is carried out to train the teaching skills of teachers following the lesson plan that has been prepared. In this activity, other teachers provided input from the results of their learning methods. The results of the work of the teachers and their study groups in the first cycle of the second meeting, such as patterns of house shapes from matchsticks and seeds, photo frames made of matchsticks, seeds, sand, and plasticine, family photos of snails, limbs of dry leaves. As is the nature of the loose part, the pieces that can be played freely and cannot be predicted will become (Qomariyah & Qalbi, 2021). The loose part supports children's development of different and unique ways of thinking. Since it has no binding rules, the possibilities are endless and can be further explored by children. Materials can stimulate children's development to recognize their thinking potential. Children can choose what objects they will play with and want to play.

In the first cycle of the third meeting, the researchers determined the theme "universe," and then the teachers determined the sub-themes freely. Some choose the sub-themes of celestial bodies, natural phenomena, day and night, rain, rainbows, and others. In the end, teachers are welcome to present activities and do acting micro-teaching. The teachers' media work results are patterns of moon shapes from cotton and dry leaves, rainbow patterns from origami paper, cotton and dry leaves, and day and night from beads. In this theme, children can learn about earth and space science by interactive media (Syarfina et al., 2024).

Observation. Observations revealed activities that can improve teacher competence in implementing the STEAM learning method from loose parts. Based on the collaborator's notes, at the first meeting, the teacher could still not explain each indicator of STEAM learning; the teacher needed clarification about determining loose parts materials to be used as examples of learning. Most of them also should have taken note of the critical points conveyed by other colleagues. None of the teachers looked sleepy, but some responded between close colleagues, so many spoke while others presented. Teachers still need to use loose parts materials to make learning media examples. However, the teacher started to be active at the next meeting, asking questions and giving opinions in determining the project. After the researcher carried out the first cycle of action, the next step was the researcher and collaborator conducting an evaluation.

Evaluation. To evaluate the implementation of the action in the first cycle, the researcher assessed the results of the loose part STEAM learning design made by the teacher in the form of lesson plan, work, and presentations. Performance assessment is carried out to determine the extent of teacher competence in implementing STEAM from loose parts. The results of this assessment consider whether action needs to be taken in the next cycle. In addition, successes and obstacles while implementing the action were evaluated based on field notes and observation sheets—the average percentage of teacher achievement in implementing the STEAM learning method made from loose parts. As many as eight teachers are above 80%, and seven are below 80%, around 60-75%. The average score has yet to meet the minimum achievement set by the authors and collaborators; 80% of the total participants scored above 80%. The criteria for success in research are said to be successful if 12 out of 15 teachers have an average score of 80%. Based on the data from the first cycle, the authors and collaborators decided to take the second cycle with several improvements.

Idea Improvement. Based on the data obtained from the work and observations, it is necessary to reflect on the Based on the data obtained from the work and observations, it is necessary to reflect on implementing the first cycle. On this basis, researchers and collaborators discuss the obstacles found and then make improvements. The reflection results obtained for improvement in cycle two are: (1) the project specified is still straightforward, (2) the manufacture of media from loose parts provided is not maximized, and (3) ideas are still similar between one participant and the other participants, (4) the teacher's lack of attention in discussions and providing input, (5) the STEAM material cannot be understood thoroughly, (6) not all teachers are confident in presenting their work, (7) time management at the second meeting could have been better.

The improvements made in cycle two after the reflection were: (1) showing videos of loose parts project results designed by teachers in Indonesia and the world, (2) teachers are welcome to bring additional loose parts materials for the next project to be more innovative, (3) STEAM-based lesson plan and learning media produced from loose parts materials are designed in more detail, (4) each lesson hour is paused with ice breaking so that

participants do not fall asleep and stay enthusiastic in the discussion, and provide input for presentations, (5) motivate that all works are good so that teachers are brave and confident in teaching simulations and presenting their work.

Cycle II

By using project-based learning (PjBL), significant improvement of teacher competence in implementing STEAM learning methods from loose parts in early childhood showed in Table 1.

Table 1. The average percentage of teacher competence improvement in implementing STEAM learning using loose parts through PjBL

Number	Name	Percentage			
		Pre-Cycle	Cycle I	Cycle II	Increase
1	FD	60,5	87,5	97,9	37.4
2	ED	65,6	80,6	93,8	28.2
3	SW	61,7	73,6	85,4	23.7
4	SW	60,8	75,0	95,8	35.0
5	NN	63,4	70,8	72,9	9.5
6	DS	55,1	66,7	93,8	38.7
7	SS	53,3	69,4	89,6	36.3
8	CSM	63,4	70,8	81,3	17.9
9	YD	67,0	83,3	93,8	26.8
10	SM	62,1	83,3	95,8	33.7
11	DF	65,5	88,9	97,9	32.4
12	ER	64,5	83,3	95,8	31.3
13	DT	63,3	87,5	97,9	34.6
14	LM	67,5	86,1	97,9	30.4
15	NA	50,5	62,5	75,0	24.5
Completion per Cycle		61,6	78,0	91,0	29.4

After evaluating pre, cycles 1 and 2, the value of the teachers has met the criteria that indicate completeness. The average percentage increases in cycles I and II was 29, 4, which means 13 teachers got an average score above 80%. The data results indicate that researchers and collaborators have agreed upon the minimum developmental achievement level (DAL).

In cycle II, the teacher determines the project to be run and designs learning media from loose parts material without being determined by theme and sub-theme. In addition, besides loose part materials that have been provided, teachers are also welcome to bring loose parts consisting of natural materials and used materials in the environment around the house, which will be used in making learning media from loose parts. It is conducted by the researchers and the team so that teachers can be more creative and explore the results of their thoughts in the form of work. This finding was supported by research stating that teachers' creative self-efficacy mediated the relationship between their creative role identity and implementation attitudes(Huang et al., 2019).

At this stage, the teachers are also directed to create and plan an lesson plan that explains the application of the STEAM learning method in more detail. Next, the teachers completed the learning media project from the material of the loose parts. After the teachers finished making the loose parts of the learning media, the teachers made a presentation in front of the other teachers. In addition to presentations, teachers were asked to provide examples of teaching using the STEAM (micro-teaching) learning method and other participants acting as students. The teachers' work results in cycle II are turtles made of plastic cakes and origami, figure trees from used drink bottle caps, airplanes from used drink bottles, cars from used drink bottles, straws and balloons, fish from used egg nests, canoes made from fronds, bananas, and skewers.

Media designed with loose parts materials are more creative and innovative. Loose parts are used as STEAM learning materials because they adapt to the uniqueness of children, can be adapted and manipulated in many ways,

support children's creativity and imagination, and can develop children's ideas in a fun way. Research said that loose parts play interventions introduce moveable materials and equipment to children's play spaces to facilitate unstructured, child-led play (Gibson et al., 2017). Loose parts not only support children's development but also help children connect with their environment. Toys are designed with a specific purpose, and children usually use them in one or two ways. Children who carry a basket full of cars will usually use the car to play as if they were driving a car. Nevertheless, when children use objects from nature, they can use them for anything according to the child's ideas. It will develop children's imagination, creativity, language, and knowledge (Nurjanah, 2020; Siti Wahyuningsih et al., 2020). The results showed that the activeness of the participants, the courage in teaching and presentations, and the teacher's confidence increased. Based on this evaluation, the action on increasing ECE teachers' competence in implementing the STEAM learning method made from loose parts was stopped until cycle 2.

4. Conclusion

Using PjBL model to improve the proficiency of ECE teachers in implementing the STEAM learning method made from loose parts involves teachers actively and creatively in the learning process. Through PjBL, teachers can compile STEAM-based lesson plan, produce works in the form of learning media made from loose parts, and assess children's development based on developmental aspects associated with STEAM. Authentic assessment analysis from cycles one and two showed that the average value of ECE teacher competence increased. The PjBL method improves the process and learning outcomes for teachers in improving the competence of ECE teachers towards the STEAM learning method, loose parts-based and implementing it in their respective institutions. Undertaking projects using the PjBL model, increasing teacher understanding, and producing work can also increase teacher confidence and teaching skills.

The PjBL model could be used for learning or training to improve competence, involving educators, policymakers, employees, and members of organizations, not only in schools. ECE teachers should receive assistance from early childhood institutions in implementing the STEAM method, which uses loose parts. Studies on the extent of STEAM implementation by ECE teachers can be used in the future research.

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