STEAM-Based Learning Implementation Plan: Integrating Science, Technology, Engineering, Art, and Mathematics in Teaching Indonesian Language Education

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ABSTRACT

The purpose of this study was to describe the ability of teachers and various factors that support and hinder the ability of teachers in preparing STEAM-based learning implementation plans. The data sources in this study were 30 learning implementation plans that had been prepared by Indonesian language teachers who had participated in teacher professional education training activities at a private university in Jakarta. The method used in this study was content analysis. In addition, data collection was also carried out through structured interviews to explore the opinions of teachers about the supporting and inhibiting factors experienced by teachers in the training of preparing STEAM-based learning plans. The results of the study showed that the average ability of teachers in preparing STEAM-based learning implementation plans was very good, namely (80). This means that they have been able to describe the learning steps using the STEAM approach well. The success factor for teachers in preparing STEAM-based learning implementation plans (LIPs) is influenced by the readiness of the implementing agency, instructors, and the optimal support of certain personnel.

Keywords: learning design, teacher competence, STEAM

INTRODUCTION

The STEAM approach aims to integrate learning related to science, technology, engineering, arts and mathematics (Anito & Morales, 2019); (Milara et al., 2020); (Heuling, 2021), which is a learning approach based on scientific technology and the ability to solve problems in the real world

(Kofac, 2017); (Thuneberg et al., 2018). STEAM has emerged as a cross-disciplinary learning model that explicitly aims to develop creative thinking skills (Malele & Ramaboka, 2020); (Wu, 2022). As an educational approach that supports the industrial revolution 4.0 (Nguyen et al., 2020); (Sopapradit & Wannapiroon, 2022), STEAM uses the development of collaboration and communication skills (Taylor & Lowe, 2021). Through STEAM-based learning, students' personal and interpersonal competencies can be developed more optimally. Students' ability to reason and interact to solve and provide benefits together with students or other people will always be honed. In the field of tourism education, the use of the STEAM method can provide students with more effective learning experiences so that they can improve student learning outcomes (C.-H. Liu et al., 2024). STEAM education and digitalization as a means for humans to be the central actors in the construction of a sustainable society that favors a sense of worth and global wellbeing (Aguayo et al., 2023).

Various research results have been carried out regarding the effectiveness of using STEAM in learning. Among them is that STEAM is able to direct students to solve complex problems and develop creative and critical thinking (Perignat & Katz-Buonincontro, 2019); (Arce et al., 2022). Students have a positive perception of the use of STEAM because it applies learning that is important for updating science and mathematics learning (Bush et al., 2020). Utilizing the STEAM approach can improve student learning achievement (Khamhaengpol et al., 2021); (Piila et al., 2021). Recent research also proves that STEAM-based learning activities have a significant relationship with the quality of student independence (Handayani et al., 2023).

Several previous research results related to the competence of teachers in Indonesia in implementing STEAM-based learning have not shown optimal abilities. Teachers have low competency to implement STEAM learning. This is due to teachers' lack of knowledge and understanding about STEAM (Kartini & Widodo, 2020). Some science teachers are familiar with the STEAM approach, but still do not have in-depth knowledge to implement the STEAM approach (Efwinda et al., 2021). Likewise, regarding thematic learning, the implementation of STEAM-oriented thematic learning is also not optimal (Regina et al., 2022).

Many factors influence the lack of ability of teachers to implement STEAM-based learning. Among these is the teacher's ability to prepare learning implementation plans. Learning implementation plans are an important aspect in achieving learning objectives (Nirtha et al., 2021). The Learning Implementation Plan is a guide to implementation learning activities for each lesson (Sanjaya, 2006); (Fouryza et al., 2019). Learning implementation plans also have an important role in creating meaningful learning strategies and activities (Veloso et al., 2021).

To date, however, no studies have explored the competence of teachers in preparing STEAM-based LIPs. Several previous studies related to STEAM focused primarily on the effectiveness of using STEAM in learning and the competence of teachers in carrying out learning with the STEAM approach. Therefore, this study aims to extract empirical data about the competence of teachers who have participated in teacher professional education training activities in preparing lesson plans. During the training, the teachers were equipped with both knowledge-based and practical resources. Some knowledge-based materials concerned scientific learning education, and teaching materials related to certain subjects. Some of the training materials that were practical in nature presented techniques for preparing learning tools, including lesson plans, teaching media, and STEAM-based learning evaluation instruments.lesson plans, teaching media, and STEAM-based learning evaluation instruments.

Research on the competence of teachers who have participated in teacher professional education activities that use the STEAM approach to prepare lesson plans is critically important because it offers an empirical and practical contribution to advance professional development programs for teachers. This research will generate new knowledge about the level of effectiveness of past implementations of teacher professional education training. In addition, information will be obtained about both factors that support successful training activities and factors that inhibit success. Thus, the data obtained can provide a foundation for determining policies related to the future implementation of professional education for teachers.

METHOD

a. Research design

Epistemologically, this research is qualitative research that uses a content analysis design. This research refers to procedures from Mayring (2014), which consists of formulating the issue or problem, determining material samples, forming a category system, determining which text elements will be examined for frequency, category definition, determining units of analysis, coding or categorizing data, calculations, namely building and comparing frequencies, description and interpretation of results. Data categorization is done by matching the descriptions of learning steps that have been prepared by teachers with the principles of STEAM-based learning, namely in the form of descriptions to direct students' attention and motivation, activate students in learning, involve students directly in learning, carry out learning in a challenging and enjoyable way, provide reinforcement or feedback on student achievement, and carry out learning by paying attention to differences between students.

The implementation plan documents analyzed are a number of documents that have been uploaded by all teachers participating in the teacher professional education training activities through the learning management system (LMS) page managed by the training activity organizing institution. The learning implementation plan documents uploaded by the teachers are learning implementation plan documents that have been prepared based on the results of discussions with colleagues and direction or guidance provided by the instructors while the teachers are participating in the learning implementation plan preparation training activities. The learning implementation plan documents will later be used as a basis for teachers to continue the training to the next stage, namely learning practice.

b. Research Context

This research was conducted at a private university in Indonesia that organises teacher professional education and training activities. The data sources in this study comprised 30 LIPs documents developed by Indonesian language teachers at the junior, vocational, and high school levels. These teachers had participated in teacher professional education and training at one of the private tertiary institutions in Indonesia. They were equipped with various competencies, including both knowledge and skill competencies.

The competency knowledge provided to teachers takes the form of knowledge about the foundation of education, teaching, approaches to learning, learning models, and learning evaluation. Meanwhile, the skill competencies that teachers are taught concern the preparation of learning tools, which take the form of STEAM-based LIPs; preparation of learning media; and preparation of evaluation instruments for measuring learning success.

Before conducting the research, the researcher communicated with various stakeholders to obtain permission to explore and collect data related to the learning implementation plan. The data related to the interview was conducted by first communicating regarding the willingness of the teachers to become respondents in order to explore data on various factors that influence their ability to prepare a STEAM-based learning implementation plan. In order to respect and maintain the confidentiality of the learning plan documents analyzed and the sources who are the objects of this research, the researcher eliminated the mention of ownership of the documents as well as the names of the teachers who were respondents in this research.

c. Data Collection and Data Analysis

Data collection was carried out by interviewing a number of teachers who had participated in teacher professional education activities. Data collection about the teachers' ability to develop LIPs was measured by referring to the rubric whose criteria are based on the principles of STEAM-based learning. STEAM-based learning is based on these six principles: attention and

motivation, active engagement, direct involvement, challenge, feedback and reinforcement, and individual differences (Ariyana et al., 2018). The LIP prepared by the teachers was analysed by taking into account the principles and examples of implementation.

Table 1:
STEAM-based Learning Principles

Principle	Learning Activities
Principles of attention and motivation	Teachers provide contextual problems designed to increase student interest and motivation for problem-solving.
Principle of liveliness	Students are directed to realise that problems may be solved with any of a variety of cognitive strategies, including associating problems with existing knowledge, making comparisons and assumptions (associations), and thinking inductively and deductively.
Principle of direct involvement	Students are given exercises in the form of worksheets and questions as an opportunity to repeat learning with various learning resources.
Challenge principle	Students are given a set of concepts and asked to identify which are relevant to the STEAM field being studied and which are irrelevant.
The principle of feedback and reinforcement	Students who have succeeded are rewarded with medals and new challenges. Receiving praise for their efforts encourages students to be more active in learning and more enthusiastic.
Principle of individual differences	Students must be helped to understand their individual strengths and weaknesses, as this helps to ensure that each student receives services tailored to their abilities and needs.

Data on the supporting and inhibiting factors for teachers' successful preparation of STEAM-based LIPs were collected from interviews conducted via Google Forms. The link to the form was sent to the WhatsApp group of teachers participating in professional teacher education and training. After obtaining approval from the training organisers, we explained the aims of our research and asked the teachers whether any of them would be willing to become research participants. Thirty teachers, and thus a significant proportion of the group, expressed their willingness to participate in the interview.

The interviews were guided by three broad questions. How did the participant understand the STEAM approach to learning? What factors enabled the participant to develop LIPs using the STEAM approach? What factors caused the participant difficulty in preparing LIPs using the STEAM-based approach? The results of the interviews were used as a basis for drawing conclusions about both the factors that promote success in developing implantation plans through the STEAM approach and factors that inhibit it. The findings of the data analysis were then categorised using criteria based on quality standards set by the universities that provide education and training for the teaching professional (Uhamka, 2019).

Table 2:

Range of Teacher Ability Categories in Preparing Plans For Implementing STEAM-Based Learning

Value Range	Category
80 - 100	Very good
70 - 79	Good
56 - 69	Enough
45 - 55	Not enough
0 - 44	Very less

FINDINGS AND DISCUSSION

a. Teachers' Ability to Prepare STEAM-Based Learning Implementation Plans.

The results of the analysis of the learning steps in the lesson plan that have been prepared by the teachers are not fully in accordance with the principles of STEAM-based learning. The following are the results of the analysis of the teachers' abilities in describing the STEAM-based learning steps outlined in the learning implementation plans (LIPs)

Table 3:

The Teacher's Ability to Prepare Plans For Implementing STEAM-Based Learning

Description of the Principles of the STEAM Approach	Average Teacher Ability	Category
Principle of liveliness	100	Very good
Principles of attention and motivation	43.33	Very less
Principle of direct involvement	100	Very good
Challenge principle	50	Not enough
The principle of feedback and reinforcement	70	Good
Principle of individual differences	6, 67	Enough
Average	80	Very good

The teachers were well able to describe learning activities related to the principle of activeness; on average, their ability was assessed as very good. All teachers were able to plan lessons and activities that encouraged students to be actively involved in learning. At the beginning of a lesson, such efforts included delivering opening greetings, praying before learning, asking the students how they felt, prompting them with questions about materials from earlier lessons, and using ice-breaking questions before beginning the lesson. When carrying out the core learning activities, the teachers stimulated their students' interest by asking questions related to the teaching materials. The teachers also developed plans to guide their students in actively studying and discussing the practice questions contained in the worksheets. At the end of the learning activity, the teachers stimulated curiosity by providing opportunities for each student or group to present their work, summarising the material they had learned. The dimensions of teaching quality positively related to learning achievement were teacher support, classroom management, and cognitive activat (Sanfo & Malgoubri, 2023).

The efforts to activate students planned by the teachers are very beneficial for teachers and students. The establishment of effective interaction between teachers and the teacher's attention is also related to students' desire to be actively involved in learning. This can be indicated by the number of students who respond when the teacher asks the students something (Kosel et al., 2023). Student activity when studying will provide a more in-depth learning experience. Providing opportunities for each student or group can also grow students' self-confidence. Teacher quality is an important factor that influences the quality of learning and student learning outcomes (Yang & Kaiser, 2022).

The principles of attention and motivation planned by the teacher in the learning implementation plan have not been fully described clearly. Of the number of learning implementation plans analyzed, only some have described motivation explicitly. These motivational expressions are in the form of images or statements that motivate students to take the lesson seriously. The lack of optimality of teachers in planning learning that encourages student motivation is contrary to what was stated by (Muhonen et al., 2023), that students' social and emotional relationships have a very close relationship with the teacher's attention. Motivation provided by a teacher or instructor will have a positive influence on students' learning attitudes. Teacher motivation plays an important role in improving the quality of work (Huo, 2023). Motivation is a key component of teacher professional competence in improving students' self-regulated learning (Jud et al., 2023).

The principle of direct involvement planned by teachers in the lesson implementation plan has been well described. All learning implementation plans have described efforts to involve students directly in learning. In each learning activity, the beginning, this, and the end of learning activities emphasize students being directly involved in learning. This is done by asking students to pray before starting learning, asking students to study the exercises in student worksheets, and asking students to present the results of their work. Other students are asked to provide feedback on the achievements made by their friends in turn (Howell, 2021). Active learning approaches can also help produce better detection models (Guerra-Manzanares & Bahsi, 2023). Thus, active experiences during instruction appear to be especially important for supporting children's long-term memory (Brezack et al., 2023).

Even though the learning plans prepared by the teachers have activated students and directly involved them, they are not yet challenging. The learning activity plans prepared by the teacher have not provided optimal challenges to students. These findings are different from the findings of (C.-L. Liu & Lai, 2023) regarding the exploration of a teacher's behavior in the context of mobile learning. In his research, information was obtained that teachers tried hard to create a positive learning atmosphere. Ignoring the challenges experienced by students can affect student collaboration in many ways, such as creating a learning atmosphere, participation, and student learning satisfaction (Koivuniemi et al., 2018). Providing challenging learning assignments is very important (Barbier et al., 2022). Challenging situations can be achieved through processes and the use of various learning supports used by teachers (Pfund et al., 2004). A challenging learning atmosphere can enhance students' learning experience more deeply. Students' learning experiences contribute to fulfilling psychological, cognitive, emotional and social needs in language learning (Rahimi & Keng Wee Ong, 2023).

Teacher competence in describing feedback and reinforcement activities is good. Feedback and reinforcement in learning is a form of appreciation by the teacher to students for the students' learning outcomes. Feedback and reinforcement can increase student enthusiasm because they feel that their achievements have been appreciated. Most implementation plans prepared by teachers describe feedback or reinforcement of student achievement. The form of reinforcement or feedback is in the form of a general statement, namely in the form of "The teacher provides reinforcement, praise, or appreciation for the results of the student's presentation." This form of praise is in line with research from (Sun & Ruef, 2023) regarding the relationship between teacher praise and the formation of student competence. According to him, teachers rarely use person-based praise (e.g., "you are smart") and often give general praise (e.g., "good"). Research from (Guo et al., 2019) also illustrates the same thing, that teachers in high achieving schools give lots of praise, feedback, and orders to students. These patterns of teacher praise can contribute to the formation of different normative identities. Some feel more exclusive and some feel more inclusive. Students who receive praise from teachers can achieve more. Likewise, teachers who are praised also give higher grades to their students (Cotofan, 2021).

Principles asidefeedback and reinforcement or praise, in STEAM learning must also pay attention to the principle of individual differences. This is because individual differences are a necessity that teachers must pay attention to and provide specific services for. Individual differences between students (e.g., cognitive skills and note-taking styles) are one factor related to learning (Wilson et al., 2023). The competence of teachers in describing learning plans that take into account individual differences is quite good. This means that some teachers have been able to describe learning that pays attention to individual differences well. These findings are different from the findings of (Yotta, 2023) about differences in students' learning styles in English classes. Research findings show that most Chamo secondary school teachers in Arba Minch, Ethiopia do not accommodate different learning styles in the classroom. To support learning teachers must consider individual differences (Wilson et al., 2023). Understanding individual differences has implications for increasing teacher competence in adapting learning (Anderson et al., 2021). Beliefs regarding teacher competence are also closely related to improving the quality of learning (Runge et al., 2023).

Research findings regarding the ability of teachers in preparing STEAM-based learning implementation plans who have participated in professional teacher education and training activities illustrate that the education and training programs they have participated in have been effective. The ability of teachers to prepare STEAM-based learning implementation plans will be a strong support for teachers to be able to carry out effective learning practices. This is as stated by Beckmann & Ehmke

(2023), that preparing learning plans is a core task for teachers. Teacher competence in designing learning is an important aspect of educational success (Safi'i et al., 2023). Teachers' professional competence to make plans in selecting tasks and preparing for task implementation is very important to start meaningful learning (Hammer & Ufer, 2023).

The professional competence of Indonesian language teachers in preparing learning implementation plans will be able to support the improvement of education in Indonesia. The quality of education will certainly have implications for increasing Indonesia's human resources. Finally, the hope of improving the quality and progress of the nation will gradually be realized. This is also in line with various previous research results, that the quality of education has a significant influence on economic improvement and the nation's progress. There is a relationship between economic development and higher education (Mussaiyib & Pradhan, 2024; Van Le & Tran, 2024). Making good learning plans also opens up opportunities for teachers to prepare teaching materials well. The choice of good teaching materials will influence the level of achievement of learning outcomes. This is in line with what Narmaditya et al. (2023) stated regarding the field of economics, that education or family economics teaching materials have a very significant relationship to students' economic behavior. Family economic education can increase students' economic literacy and entrepreneurship.

The STEAM approach as stated in the previous section also has a significant impact on student competence. The STEAM approach emphasizes a fun learning process and actively involving students will provide opportunities for students to think critically and creatively in responding to various problems presented in the learning process. This is in line with the opinion of Aguayo et al. (2023), that STEAM is a learning approach that prioritizes self-esteem and global well-being. STEAM education has a significant impact on increasing students' learning engagement, cognition, self-confidence, and innovative thinking skills (Bui et al., 2023). In the tourism and hospitality education sector, the use of the STEAM approach can improve student experiences (C.-H. Liu et al., 2024). The use of the STEAM model can also support the implementation of distance learning. Distance learning can be an alternative for implementing learning (Almubarokah & Arifani, 2021).

b. Supporting Teachers' Abilities in Preparing Plans for Implementing STEAM-Based Learning

Based on interviews that have been conducted, information was obtained that there are many factors that support the success and hinder the success of teachers in preparing plans for implementing STEAM-based learning. The following are answers from respondents regarding the supporting factors for

success as well as the factors that cause the teachers' ability to not be optimal in preparing plans for implementing STEAM-based learning.

Table 4:
Supporting Factors for Teachers' Ability to Prepare Plans For Implementing STEAM-Based Learning

Supporting factors for teacher success in preparing plans for implementing STEAM-based learning	1. Thank God, thanks to the support of all parties, especially lecturers, tutors, colleagues and the principal, I was able to prepare a lesson plan using the STEAM approach while participating in teacher professional educatio activities. 2. Fun and contemporary learning media to support teachers in delivering material 3. Supporting factors in the success of preparing a lesson plans using the STEAM approach while participating in teacher professional educatio activities are First, support related to various activities in supporting teachers implementing STEM learning. Second, learning preparation and implementation in class. Third, teacher professional educatio participants' confidence in implementing STEM learning with the knowledge gained while participating in PPG activities. 4. Availability of technological infrastructure for learning in preparing lesson plans
Factors inhibiting teacher success in preparing plans for implementing STEAM-based learning	1. Feeling confused and having difficulty determining the right time allocation for learning, difficulty formulating indicators of 6 competency achievements and determining learning methods in the lesson plans, confusion in formulating indicators for each

lesson, Difficulty determining and combining learning objectives

2. Insufficient facilities, infrastructure and lack of teachers who understand STEAM and always focus on the subject they teach, lack of respect for other subjects to collaborate

3. Insufficient time allocation means that the preparation of the lesson plans is not optimal.

4. The obstacles faced are why we have not been able to prepare lesson plans using the STEAM approach, one of which is that some of the topics are very difficult to apply to learning using the STEAM approach.

Based on the results of interviews with teachers, information was obtained that the supporting factor for teachers' abilities in preparing STEAM-based learning implementation plans was thanks to support from all parties, especially lecturers, tutors, colleagues and school principals. The intended support from lecturers and tutors is in the form of strategies for conveying knowledge information and mentoring techniques carried out in the process of preparing plans for implementing STEAM-based learning. Colleagues contribute by providing input during the presentation of learning implementation plans that have been prepared by other fellow teachers. This is in line with the results of research from (Wittmann & Wulf, 2023), that the instructor's attitude can facilitate improved learning outcomes for students or in this case trainees. The relationship between trainees and instructors can be analogous to the relationship between teachers and students. According to (Sethi & Scales, 2020)Students' relationships with teachers, parents, and friends impact students' academic experiences and success. Likewise, in teaching that utilizes AI technology as an instructor, the perceived credibility of the AI instructor positively influences students' intentions to enroll in future AI instructor-based online courses (Kim et al., 2022).

Then the role of the leader or principal is to provide opportunities for training participants to be able to participate in activities optimally. School principals do not provide additional workload to teachers while participating in professional teacher education and training activities. These supporting factors for success are in line with several research results, that effective learning depends on a shared vision, effective leadership, supporting facilities, and a collaborative and innovative culture (Guo et al., 2019). A good

managerial system is able to support increasing teacher competence (Cotofan, 2021). Motivation, hope, involvement, and level of cooperation influence success in training activities (Marion & Mann-Feder, 2020). In addition, teacher training is directly related to the quality of the educational process (Caballero & Llorent, 2022). Developing teachers and administrators through leadership work can increase relational trust, expand capacity, increase professional capital, and improve outcomes for students (Eckert, 2023).

The factors that inhibit teachers' ability to develop STEAM-based LIPs can be divided into two categories: personal and instrumental factors. Personal factors include teachers' lack of understanding of the STEAM approach and a number of difficulties – difficulties in choosing subjects to integrate with the STEAM approach; determining and integrating learning objectives; formulating learning achievement indicators; and timing the training implementation, which often coincides with other training activities. Instrumental factors include limited facilities and infrastructure, unstable networks when participating in training activities that are held online, inadequate time allocation, and an absence of examples when preparing LIPs using the STEAM approach. Meanwhile, various personal factors can influence the participants' anxiety in participating in training activities. Anxiety will affect concentration and success in participating in training activities. As stated by (Lee et al., 2023), anxiety directly affects the readiness of participants. An individual's anxiety when participating in activities will also affect their ability to establish interactions and manage emotions. Social and emotional skills are important in supporting one's academic success (Soto et al., 2023).

The results of the interview are related to the teacher's not yet optimal ability in preparing plans for implementing STEAM-based learning in accordance with the research results (Sartika et al., 2020) regarding teacher competence in preparing learning plans. The learning tools prepared by teachers have not been able to build and direct good understanding for students. The readiness and quality of teachers' learning tools are also not yet relevant to the characteristics of the curriculum that have been determined (Nurtanto et al., 2021). Thus, efforts to use learning tools as a procedural basis for teaching have not been carried out optimally. Teaching carried out by teachers may be carried out without careful planning. As a result, learning outcomes have not been achieved optimally. Moreover, it is related to developing students' abilities in solving problems. The quality of education can increase due to optimal teacher performance and competence (Wicoksono et al., 2022). Beliefs related to teacher competence are very important in determining teacher professional competence and the quality of learning (Runge et al., 2023).

The description of the research results regarding the competence of teachers in preparing learning implementation plans shows that qualitatively the ability of teachers in making learning plans using the STEAM approach

is not optimal. Teachers have just understood the structure or syntax of learning using the STEAM approach, but the description of the activities that must be carried out in each syntax has not been clearly described. The teachers' abilities which are not yet optimal are influenced by the teachers' technical abilities in understanding the content contained in STEAM. Apart from that, it is also caused by the low demand for teachers to explore knowledge related to STEAM. As a result, the preparation of learning implementation plans prepared by teachers does not reflect efforts to think systematically and deeply in making plans for implementing STEAM-based learning. The learning implementation plans prepared by teachers are often just copies of previous learning sources and there is not enough time to be scrutinized regarding their suitability to the content of the teaching material. This is in line with research results from Kartini & Widodo (2020); Regina et al. (2022), that the low competence of teachers in preparing STEAM-based learning implementation plans is due to teachers' lack of knowledge and understanding about STEAM.

This morning training activity for teachers in preparing STEAM-based learning implementation plans is part of other professional teacher education and training activities. The planning for implementing STEAM-based learning was carried out in stages, namely by using a genre pedagogy approach. This approach consists of four stages, namely building context, reviewing models, constructing together, and constructing independently (Safi'i et al., 2020). Genre pedagogy is a learning approach that focuses on implementing a student-centered teaching and learning cycle(Varga et al., 2023). The application of genre pedagogy allows classroom assessment practices, such as diagnostic assessments and student involvement in assessments to take place effectively (Acar, 2023).

At the context building stage, the instructor directs all participants to be ready to take part in the training activities that will take place. This is done by praying first and emphasizing the importance of participating in training activities seriously and responsibly. This context-building stage is also used to direct the motivation of the participants. This is as stated by Sujiatmoko, (2021), that motivation has a very important role in supporting the success of learning. In the model review stage, the instructor provides an example of a learning implementation plan that has been prepared using the STEAM approach. Participants or teachers are directed to examine the similarities and differences with learning implementation plans that have been prepared using approaches other than STEAM. Based on the teachers' understanding and ability to identify the characteristics of a STEAM-based learning approach, the instructor then directs the teachers or trainees to work in groups to prepare learning implementation plans related to certain teaching materials using the STEAM approach. After receiving reviews from other groups and instructors regarding the preparation of STEAM learning implementation plans, then independently, each participant was directed to create a STEAM-

based learning implementation plan according to the teaching materials that would be used in learning practice.

At the stage of preparing an independent learning implementation plan, it is not uncommon for training participants to behave pragmatically. This means that students have a tendency to duplicate previous learning implementation plans without reviewing and adapting them to the needs and characteristics of STEAM. This was done by the training participants due to limited time and because they were busy with other activities outside of the education and professional teacher training activities they were participating in. Therefore, efforts are needed to direct participants to a thorough understanding of the STEAM approach and its implementation in the learning implementation plans they will prepare. The instructor emphasized that teachers who are not careful in preparing the learning implementation plan must repeat the preparation of the learning implementation plan again by paying attention to the working steps of the STEAM approach in learning.

The STEAM approach emphasizes an interdisciplinary approach to learning that is different from traditional approaches. The findings of this research can help design tailored professional development programs to support teachers in implementing STEAM approaches effectively. This Education and training program emphasizes interdisciplinary skills, use of technology, and creative teaching strategies. Teachers are not solely required to master the fields of science, technology, engineering, arts and mathematics, but rather adopt the thinking skills contained in these fields. This is in accordance with what was stated by Lage-Gómez & Ros (2024), that STEAM enables a balanced reciprocal relationship between various forms of creativity, namely scientific, artistic and craft. Creativity training that integrates STEAM activities can be an effective approach to foster creativity (Gu et al., 2023).

The ability to think and behave from the results of STEAM-based learning can be a provision or foundation for teachers and students to think critically and creatively in solving various challenges. Moreover, for students who have opportunities for global cultural connectivity, STEAM-based thinking skills will be able to help students to interact and create effectively. The STEAM approach can help teachers connect science authentically with real-world issues that have social and cultural relevance to students' everyday lives (Mang et al., 2021). The STEAM approach will also be able to increase student activity and teachers also have an important role in activating students (Tanore, 2023). Thus the STEAM approach can also play an important role in aligning the expectations of the education system in educate students and developing the workforce (Minces & Akshay, 2023).

CONCLUSION

STEAM is a learning model that uses the basic thinking of science, technology, engineering, art, and mathematics. One of the efforts for teachers to implement STEAM-based learning is to be able to prepare a learning plan by paying attention to and using the principles of STEAM-based learning, namely the principles of activeness, attention and motivation, direct involvement, challenges, feedback and reinforcement, and the principle of individual differences. The ability of teachers who participate in teacher professional education activities from one of the private universities in Indonesia in preparing a learning implementation plan with a STEAM approach is very good. The success factor for teachers in preparing a STEAM-based learning implementation plan (RPP) is influenced by the readiness of the implementing institution, instructors, and optimal support from certain personnel. One of the obstacles to the success of teachers in making STEAM-based learning plans is an unstable internet network. This research did not involve all teachers who had taken part in professional teacher education and training activities. Therefore, the data obtained is still not comprehensive. However, the results of this research can be used as an effort to measure the effectiveness of professional teacher education and training activities that have been carried out. Further research using a wider sample from several universities providing professional teacher education and training needs to be carried out so that more comprehensive data can be obtained. In this way, the results can be generalized more thoroughly.

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