

Training on the STEAM Learning Model to Improve the Competence of Elementary School Teachers

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Article Info

Article history:

Received: January 26, 2026

Accepted: March 23, 2026

Published: May 29, 2026

Keywords:

Elementary school

Science

STEAM

Teachers

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Pengabdian Masyarakat

Abstract

This community service activity aims to improve the professional competence of elementary school teachers in Barru Regency in designing and implementing the Science, Technology, Engineering, Arts, and Mathematics (STEAM) learning model in Science subjects. Twenty-first-century learning requires teachers to integrate multiple disciplines to develop students' critical, creative, collaborative, and communicative skills. However, in practice, elementary school teachers still face limitations in understanding and skills in implementing integrated STEAM-based learning. The implementation method for this community service uses a training and mentoring approach, including the socialization of STEAM concepts, workshops on developing STEAM-based science learning tools, teaching practice, and reflection and evaluation. The results of the activity indicate an improvement in teachers' understanding of the STEAM concept and their ability to develop STEAM-based science learning tools. This activity is expected to contribute to improving the quality of science learning in elementary schools.

To cite this article: Amran, M., Sahabuddin, E. S., Usman, U., Majid, A., & Alfatih, A. N. (2026). Training on the steam learning model to improve the competence of elementary school teachers. *Bubungan Tinggi: Jurnal Pengabdian Masyarakat*, 8(2), 377-386.

INTRODUCTION

Rapid developments in science and technology require education systems to adapt to the demands of 21st-century learning. Education today is directed not only toward mastery of content but also toward the development of higher-order thinking skills (HOTS), creativity, collaboration, and effective communication ([Khoiri et al., 2024](#); [Ragab et al., 2024](#); [Saregar et al., 2021](#)). Therefore, teachers are required to implement innovative learning approaches that are relevant to students' real-life contexts ([Darling-Hammond et al., 2017](#)). To apply 4C skills in classroom practice, teachers need to understand current student-centered learning paradigms ([Trilling & Fadel, 2009](#)).

One learning model considered capable of addressing these challenges is Science, Technology, Engineering, Arts, and Mathematics (STEAM). The STEAM learning model is a development of STEM by incorporating elements of art as a means to foster creativity and innovation in the learning process ([Misbah et al., 2024](#); [Yakman, 2008](#)). The integration of art in STEAM allows students to develop a more holistic conceptual

understanding and encourages creative and reflective thinking ([Henriksen, 2017](#)). Furthermore, the implementation of STEM/STEAM approaches in teacher mentoring activities has been proven to improve teachers' skills in developing innovative learning tools and integrating interdisciplinary elements into science learning ([Hidayat & Rahmawati, 2021](#); [Mulyani & Prasetyo, 2023](#)). The STEAM learning model is designed with the following steps in Table 1.

Table 1 Steps of STEAM Learning Activities ([Amran, 2025](#))

Problem Identification (Science)	• The teacher begins with a triggering question • The teacher divides students into 5 groups • The teacher presents a learning video • Students conduct observations
Technology Exploration (Technology)	• Students explore the use of technology related to the material • Students discuss topics related to the material
Design and Engineering (Engineering)	• Students create simple models or tools related to the material
Art Integration (Arts)	• Students create infographics or interactive posters • Create artwork using shadow art applications • Make paintings or collages using color effects
Mathematics Application (Mathematics)	• Measure applications, area, volume, or angles relevant to the project or experiment • Perform calculations based on obtained data for further analysis
Reflection and Presentation	• Students present their project results • Discussion on the application of concepts in real-life situations

Based on these steps, if applied in science learning in the classroom, teachers will become more creative and innovative. This will directly address the demands of 21st-century education.

At the elementary school level, science plays an important role in building students' scientific literacy and scientific attitudes. Effective science learning should provide contextual, exploratory, and meaningful learning experiences so that students can relate scientific concepts to real-world phenomena ([Bybee, 2013](#); [Suryawati & Osman, 2017](#)). In line with this, the Merdeka Curriculum emphasizes student-centered learning, encourages creativity, and develops reasoning and collaboration skills ([Kemendikbud, 2022](#)). Community service activities focusing on strengthening scientific literacy through innovative learning model training have shown improvements in teachers' understanding of strategies oriented toward 21st-century skills development ([Rahman & Fitriani, 2022](#)). Therefore, science learning delivered by teachers should aim to develop students' creativity and scientific literacy skills.

Initial observations and discussions with elementary school teachers in Barru Regency indicate that science learning implementation still tends to be conventional and content-oriented. Some teachers do not yet have adequate understanding of STEAM learning and face difficulties in integrating science, technology, engineering, arts, and mathematics into learning activities. This finding is supported by preliminary data from questionnaires and interviews, showing that approximately $\pm 70\%$ of teachers have never participated in STEAM training, and $\pm 65\%$ reported difficulties in designing STEAM-based learning tools. Additionally, observations of lesson plans indicate that most teaching plans have not optimally integrated interdisciplinary approaches. This condition is one of the factors

hindering the optimization of science learning in elementary schools. Interviews also revealed that teachers have not fully understood the comprehensive implementation of the STEAM learning model. This situation potentially hampers the development of students' 21st-century skills and scientific literacy ([Trilling & Fadel, 2009](#)).

Several studies show that STEAM-based training in community service contexts has a positive impact on improving teacher competence. [Abdira et al. \(2023\)](#) state that training activities combined with workshops and mentoring significantly improve teachers' understanding and skills in designing innovative STEAM-based learning. In addition, [Rahman et al. \(2024\)](#) found that systematically designed training using practice and reflection approaches increased teacher competence by up to 69.5% and improved classroom learning quality. Similar results were reported by [Amiruddin et al. \(2022\)](#), indicating that STEAM-based community service activities significantly enhance teachers' conceptual understanding and instructional design skills. Thus, STEAM-based training in community service activities not only improves teachers' conceptual understanding but also strengthens their practical skills and readiness to implement innovative and contextual learning.

The purpose of this activity is to improve teachers' understanding and skills in designing and implementing STEAM-based science learning systematically and in accordance with the characteristics of elementary school students. Through this activity, it is expected that teachers' pedagogical competence will improve, STEAM-based learning tools will be developed, and the quality of science learning will become more innovative, collaborative, and oriented toward developing students' 21st-century skills.

METHODS

This community service activity was conducted using a Participatory Action Research (PAR) approach. This approach was selected because it emphasizes the active involvement of partners—in this case, elementary school teachers in Barru Regency—at every stage of the activity. PAR is implemented in a cyclical process through the stages of planning, action, observation, and reflection to produce continuous improvements in teaching practices. The sequence of activities is as follows:

Planning Stage

The planning stage began with a needs analysis conducted through interviews and discussions with teachers to identify problems in science (IPA) learning and their initial level of understanding of STEAM-based learning. In addition, a literature review was conducted to provide a conceptual foundation for designing the training program. The results of this needs analysis served as the basis for developing training materials, instructional tools, and the design of mentoring activities.

Action Stage

The action stage was implemented by delivering training on the STEAM learning model. The activities included: (a) socialization of the concepts and characteristics of STEAM learning in elementary school science instruction; (b) workshops on developing STEAM-based science learning tools, including the preparation of teaching modules; and (c) teaching practice or simulation conducted by participants. The methods used included interactive lectures, group discussions, and hands-on practice to encourage teachers' active participation in designing and implementing learning.

Observation Stage

Observation was conducted during the training and mentoring process to monitor participants' engagement, teachers' ability to develop learning tools, and their readiness to implement STEAM in the classroom. Data were collected through observation sheets, activity documentation, and participant response questionnaires.

Reflection Stage

The reflection stage was conducted through evaluative discussions with participants to identify the achievements of the activities, the challenges encountered, and the need for further mentoring. This reflection served as the basis for formulating improvements and follow-up actions to ensure the sustainability of STEAM implementation in schools.

Through the PAR approach, this community service activity is not only oriented toward knowledge transfer but also emphasizes a collaborative process between the implementation team and teachers as partners in improving the quality of science learning.

This activity involved 25 elementary school teachers in Barru Regency who actively participated in all stages of the program. The instruments used in this activity included questionnaires, observation sheets, and product assessment sheets. The questionnaires were used to measure teachers' understanding of STEAM learning before and after the training; observation sheets were used to assess participation and the implementation of activities; and product assessment sheets were used to evaluate teachers' ability to develop STEAM-based learning tools.

The indicators used to assess teacher competence in this activity included: (1) understanding of STEAM concepts, (2) ability to integrate science, technology, engineering, arts, and mathematics elements in learning, (3) skills in developing STEAM-based learning tools, and (4) creativity in designing contextual learning activities.

The collected data were analyzed using both quantitative and qualitative descriptive techniques. Questionnaire data were analyzed in percentages to determine improvements in teachers' understanding, while observation and product assessment data were analyzed descriptively to describe the level of teacher competence achieved during the training.

RESULTS AND DISCUSSION

The implementation of this community service activity shows that the STEAM learning model training has had a positive impact on improving the competence of elementary school teachers in Barru Regency. This impact is evident in both conceptual understanding and teachers' readiness to design and implement more innovative, context-based science learning. Based on questionnaire results and participant reflections, most teachers stated that the training provided new insights into science learning that is more integrated across disciplines and relevant to the demands of 21st-century education. The following Table 2 presents an example of a STEAM-based learning tool designed by participants.

Table 2 Example of STEAM-based learning tool

Component	Description
Theme	Utilization of Alternative Energy
Model	Project-Based Learning (PjBL)
Activity	Creating a simple energy generator model
STEAM Elements	Science (energy), Technology (tools), Engineering (design), Arts (design aesthetics), Mathematics (measurement)
Output	A simple tool/product

Table 2 presents one example of a STEAM-based learning tool developed by the training participants. The tool is in the form of a Lesson Plan with the theme "Utilization of Alternative Energy," designed using the Project-Based Learning (PjBL) model. The

table shows that the learning activities have systematically integrated STEAM elements, including science through understanding energy concepts, technology through the use of simple tools and materials, engineering through product design processes, arts through design aspects, and mathematics through measurement and calculation activities.

The results of the activity indicate an improvement in teachers' competence in understanding and implementing STEAM-based learning. Based on analysis of 25 participants, the average pretest score was 59, and the posttest score increased to 81, representing a 22-point improvement. Furthermore, the gain score (N-Gain) analysis yielded 0.54, which falls in the moderate category. This indicates that the training was reasonably effective in improving teachers' understanding of STEAM concepts.

In addition, the assessment of the learning tools developed by teachers shows that most participants were able to integrate STEAM elements into their lesson planning. The resulting learning tools reflect more contextual, problem-based learning and encourage active student engagement.

Conceptually, teachers gained a deeper understanding of STEAM learning's nature and characteristics. They no longer view science as a standalone subject but as part of an integrated learning approach that combines technology, engineering, arts, and mathematics. This understanding aligns with [Yakman \(2008\)](#), who emphasizes that the STEAM approach promotes interdisciplinary integration to create meaningful learning experiences. Through this training, teachers identified opportunities to integrate STEAM into elementary science topics, including simple projects, problem-based experiments, and creative activities incorporating artistic elements.

Questionnaire results indicate that most teachers felt more confident in designing STEAM-based science learning after the training. Teachers stated that the workshop on developing learning tools helped them understand systematic steps for integrating STEAM elements into learning objectives, activities, and assessments. The learning tools developed reflect student-centered learning, emphasize exploration and problem-solving, and promote active student participation. This finding supports [Bybee \(2013\)](#), who argues that integrated STEM/STEAM learning can improve the quality of science education through authentic learning experiences. Delivery of training materials is listed in Figure 1.



Figure 1 Delivery of training materials

Participant reflections also indicate that hands-on practice and STEAM learning simulations provided valuable direct experience. Teachers experienced a shift in their role from being the center of information to becoming facilitators of learning. Through simulations, teachers learned to manage group discussions, guide students in completing projects, and connect science concepts to real-life contexts. This aligns with [Henriksen \(2017\)](#), who emphasizes that STEAM learning enhances creativity and reflective thinking in both teachers and students.

However, reflections also revealed several challenges, particularly related to limited instructional time and the availability of supporting facilities in schools. Some teachers noted that implementing STEAM learning requires more time than conventional approaches, especially during project planning and exploratory activities. In addition,

limited tools and materials in elementary schools present challenges for optimal STEAM implementation.

Despite these challenges, teachers remained enthusiastic about implementing STEAM learning. They were encouraged to be more creative in utilizing available resources in their school environments. The use of simple and contextual materials, such as recycled objects or natural materials, was suggested as a practical solution. This approach aligns with the STEAM principle that emphasizes thinking processes and problem-solving rather than reliance on sophisticated tools ([Erol et al., 2023](#); [Yakman, 2008](#)).

From a pedagogical perspective, STEAM learning was found to promote a shift in teachers' teaching paradigms. Teachers are no longer the sole source of information but act as facilitators, guiding students in exploration and concept discovery. This shift provides more opportunities for students to ask questions, engage in discussions, and express ideas creatively, thereby supporting the development of higher-order thinking skills ([Beers, 2011](#)).

In addition to improving teacher competence, this training also has potential implications for enhancing the quality of science learning in elementary schools. STEAM-based science learning enables students to learn through direct experience and real-life contexts, making scientific concepts easier to understand and remember. This aligns with [Bybee \(2013\)](#), who states that integrated, project-based science learning can enhance student engagement and conceptual understanding.

The findings also indicate that STEAM learning is relevant to the Merdeka Curriculum policy, which emphasizes differentiated learning and the development of the Pancasila Student Profile. Through STEAM learning, students develop not only knowledge but also collaboration, creativity, independence, and critical thinking skills. Thus, this training indirectly supports the implementation of national education policies at the elementary school level ([Kemendikbud, 2022](#)).

Furthermore, this activity contributes to fostering a reflective culture among teachers. Reflection after training helps teachers evaluate their teaching practices and plan future improvements. This reflective culture is essential for supporting continuous professional development, especially in adapting to curriculum changes and evolving student needs.

Overall, the findings indicate that STEAM learning model training not only enhances teachers' technical competence in developing instructional tools but also promotes changes in teachers' attitudes and mindsets toward science teaching. Teachers become more open to innovation and more prepared to implement student-centered learning approaches. Therefore, STEAM training and mentoring should continue to be developed and expanded to achieve a broader impact on improving the quality of science education in elementary schools.

The improvement in teachers' understanding is evident from their ability to explain the fundamental principles of STEAM learning and identify the interconnections among science, technology, engineering, arts, and mathematics within science learning contexts. This finding is consistent with [Henriksen \(2017\)](#), who states that STEAM broadens teachers' perspectives in designing creative and meaningful learning.

In addition to conceptual understanding, teachers also demonstrated the ability to develop STEAM-based science learning tools. These tools reflect contextual learning, emphasize problem-solving activities, and encourage active student engagement. This supports [Bybee \(2013\)](#), who highlights that integrated STEM/STEAM learning improves the quality of science education.

As a follow-up to the training, a structured implementation plan was developed. In the initial stage (first month), teachers implemented the developed learning tools in their respective classrooms. This was followed by 2–3 months of mentoring through regular

discussions, both offline and online, to provide feedback on classroom practices. Monitoring and evaluation were conducted periodically through classroom observations, reflective discussions, and teacher questionnaires to identify challenges and progress. The results of this monitoring were used as the basis for continuous improvement of instructional tools and practices.

The findings indicate that training based on Participatory Action Research (PAR) not only improves teachers' conceptual understanding but also develops practical skills in designing innovative STEAM-based learning. Active teacher involvement at all stages of the activity was a key factor in sustaining improvements in competence. Thus, the training approach proved effective in enhancing the quality of science learning in elementary schools.

Hands-on practice and simulation activities provided teachers with direct experience in implementing STEAM learning. Teachers showed readiness to apply this approach in the classroom, although some participants still require further mentoring, particularly in time management and adapting projects to the characteristics of elementary students. Therefore, continuous mentoring is essential to ensure successful STEAM implementation.

CONCLUSION

The community service activity in the form of a STEAM learning model training in science subjects for elementary school teachers in Barru Regency was successfully implemented and had a positive impact. The training improved teachers' understanding of STEAM concepts as well as their skills in developing and designing STEAM-based science learning tools.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

The first author contributed to the formulation of the activity concept, training design, coordination of field implementation, data analysis, and drafting of the main manuscript. The second and third authors contributed to the development of training materials, preparation of STEAM-based learning tools, mentoring activities, and data collection and analysis. The fourth author contributed to activity documentation, program evaluation, and refinement of instruments used during the training. The fifth author contributed to academic review, content validation, manuscript editing, and finalization before submission. All authors actively participated in discussing the results and approved the final version of the manuscript.

AI DISCLOSURE STATEMENT

In preparing this article, the writing team received assistance from ChatGPT across several sections to improve grammar, construct academic sentences, and refine the writing structure during manuscript preparation. However, after using this service, the authors carried out paraphrasing and comprehensive improvements to sentence structure, and the writing team is responsible for the content, data, analysis, and conclusions in this publication.

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