***STEAM (Science, Technology, Engineering, Art, and Mathematics)
Implementation and Challenges in Elementary Schools in West Java***

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Abstract

STEAM education plays a crucial part in education in the 21st century. Teachers, being one of the most essential components of delivering education, play a crucial role in implementing STEAM learning. This study seeks to investigate the deployment of STEAM learning in primary schools and the obstacles elementary school teachers encounter in applying STEAM. This study is a survey-based descriptive quantitative investigation. This study's participants were 50 primary school teachers from West Java. A questionnaire was used to collect data on the implementation of STEAM learning and the difficulties associated with it. The results of the study indicate that instructors have incorporated STEAM learning through student-centered learning, learning through inquiry and problem-based models, assessment, reflection, and collaboration, as well as applying integrated learning in both content and skills. Teachers cite pedagogical obstacles, technological obstacles, facilities, STEAM learning materials, and implementation time as obstacles to the implementation of STEAM education. It may be stated that the instructor has implemented learning activities that contribute to STEAM education. However, technical training for teachers on the technical implementation of STEAM and the supply of supporting resources, particularly technology-based facilities, are required to facilitate the implementation of STEAM in primary schools.

Keywords: STEAM Education, Difficulties, Elementary School, West Java

Introduction

Education of the 21st century is characterized by the rapid development of science and technology in affecting the order of human life especially in the field of education. Education in the 21st century requires education that has the ability in the fields of science, technology, as well as various skills such as communication skills, critical thinking, creativity and the ability to collaborate. (Nuragnia et al., 2021). The skills and abilities of the 21st century are essential to make students adapt and respond to the developments of the times. Therefore, it is important for students to have 21st century skills developed in line with scientific and technological developments. Education of the 21st century is expected to form individuals who have the skills to transform the science learned in real life and use technology appropriately in the face of the global competition, especially in 21st Century learning. (Indriyanti et al., 2020). One of the learning approaches due to the rapid development of science and technology in the 21st century is the approach of science, technology, engineering, art, and mathematics. (STEAM).

The Science, Technology, Engineering, Art, and Mathematics (STEAM) approach is one of the educational approaches that integrates science, technology, engineering, art, and mathematics comprehensively as patterns in problem-solving. STEAM learning makes learning more interesting and makes learners more creative in finding real-life problem solutions. (Atmojo et al., 2020). Learning with STEAM approaches forms students to understand the phenomena that occur in everyday life and provide solutions to these problems. The STEAM approach encourages learners to find the correlation between the science they learn with everyday life.

Steam education has attracted a lot of world attention in recent years. This can be seen from the growing trend of research-research on STEAM education internationally. (Li Wang, 2020). Several countries such as the United States, Japan, Hong Kong, and several other countries have implemented and developed the STEAM approach in their educational curricula. (Lin, 2021). In addition, Steam learning has already begun to be introduced to every level in Indonesia. One of the regions in Indonesia that first implemented STEAM learning in schools was West Java. At the age of primary school in West Java, teachers have already begun to implement STEAM learning in the learning process. Teachers become one of the important aspects of educational success as well as a key aspect in the implementation of STEAM learning in elementary schools. In addition, in the STEAM approach, teachers act as facilitators and learners as central to the collaborative learning process, integrating science, technology, engineering, art, as well as mathematics integrally. Therefore, the curriculum should focus on improving skills and soft skills that are adapted to the development of the times so that it facilitates teachers in the implementation of STEM approaches in the learning process. (Sriyanto, 2020).

Steam training has been implemented in several primary schools in West Java. However, there are still many obstacles facing teachers in the application of STEAM learning in primary schools. One of the obstacles faced is the teachers who still have very little knowledge about the STEAM approach in primary school. This is due to the lack of socialization and training carried out by the government especially in the field of education regarding learning STEAM in primary schools. Therefore, this research will exhibit on the implementation of learning as well as the challenges faced by teachers in the application of STEAM learning in primary schools. This research is expected to be a refraction for the

government especially in the field of education in taking policy for the progress of Indonesian education.

Method

The method used in this study is descriptive quantitative research with survey methods. Quantitative descriptive research is research carried out to gather in-depth information and describe a situation or phenomenon that occurs. (Kurniawan, 2018). Survey method is a method of research conducted to obtain the facts of existing phenomena. (Sukmadinata, 2010). The sample on this study was 50 primary school teachers in 10 districts in West Java. In each district, five primary school samples were taken for the process of collecting research data. The collection of data in this study uses elevators, interviews, and documentation done to elementary school teachers. The data was collected in January 2023 through the dissemination of elevators and interviews with elementary school teachers. The lifting question tool is designed to explore the implementation of STEAM learning that includes teacher perception, learning strategies, and learning approaches. The angket used to know the challenges faced by teachers in the implementation of STEAM uses the angket from Nistor et al. (2018). Data analysis in this study uses quantitative descriptive. This data analysis is obtained from the results of interviews, documentation, and logs that are systematically structured and concluded into sentences that are easy to understand. (Wicaksana et al., 2022).

Findings and Discussion

Perceptions of Teachers Regarding Science, Technology, Engineering, the Arts, and Mathematics (STEAM)

Based on the results of the research data that has been carried out shows that of 100 respondents about 30% of teachers have followed STEAM training implemented by the educational intensity. Teachers revealed that STEAM training provides benefits in knowledge of learning methods and models that can be applied in the classroom. In addition, the teacher also revealed that STEAM training helps in implementing exciting learning so that it can increase the motivation of students in learning. In addition, the benefits of STEAM training revealed by teachers are the addition of teacher insight into problem-based and project-based learning so that it can facilitate learners in learning that focuses on developing creative and innovative thinking skills. (Park et al., 2016). Meanwhile, there are still 70% of teachers who have not received STEAM training. 70% of the total teachers that have not carried out STEAM education are teachers with teaching experience in primary schools for more than 5 years so less interested in the development of learning. This shows that STEAM training has not reached teachers evenly and has not been implemented in every district in Western Java. In fact, if you look from where the teaching area is, most teachers teach in a rather developed area and not a remote place.

STEAM Education Implementation in Elementary Schools in West Java

Implementation of STEAM learning is revealed through several questions related to the implementation of learning implemented by teachers such as the learning model Project Based Learning (PjBL), the problem-based learning model (PBL), learning model Inqiury, and learning model Discovery Learning.
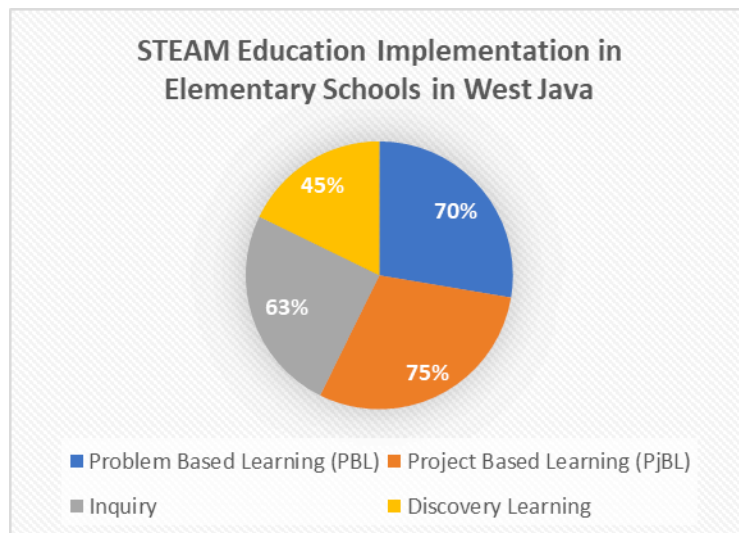
Figure 1.

According to research, 70% of teachers implement STEAM learning by integrating through a Problem Based Learning model. (PBL). The implementation of learning centered on the students according to the basis of the learning theory of STEAM is constructivism (Milara, 2019). This theory relates to the learning experience of learners as they seek to understand something through learning experiences (Gross & Gross, 2016), so that learning centered on learners provides more varied learning experiences that are tailored to the needs and learning experiences of students. To be able to improve problem-solving skills and think creatively in STEM learning, teachers need to facilitate learning so that students can play an active role. (Talib et al., 2019). The relatively high percentage of teachers who conduct learning centered on the student participant is also supported by data showing that 70,31% of the teachers carry out learning that is tailored to the needs and conditions of the student, including the student's learning style.

This is related to one of the basic theories of learning STEAM which is holistic learning. (Yakaman, 2010). Holistic learning is influenced by one's environment or influence that will help determine what one will do with the environment or objects already provided. The differences in the views of each individual into holistic learning cannot be given equally to the learners. Therefore, the learning activities must be adapted to the needs and conditions of the students in the implementation of learning. (Yakaman, 2010). STEAM learning is considered to be one of the learning that promotes holistic education. (Park et al., 2016). Data from the research also shows that about 75% of teachers implement STEAM integrated with the Project Based Learning (PjBL) model in the learning process. The STEAM-based PjBL learning approach is implemented in five stages: the reflection phase, the research phase, the discovery phase, the application phase, and the communication phase. Fitriyah's (2021) research suggests that STEAM-based PjBL learning can boost students' creative and critical thinking skills. This is demonstrated by the significant value of less than 0.05 and the computed F value of 35.55.

In addition, the application of STEAM learning in primary schools is integrated with the learning inquiry model. Based on the results of the study, 63% of teachers have applied inquiry learning that is integrated with STEAM learning in the classroom. Constructivism is the theoretical foundation of STEAM learning (Yakaman, 2010) that emphasizes learning experience through authentic inquiry, project, and problem-solving processes (Milara & Cortés, 2019). STEAM learning is context learning (Henriksenet al., 2019; Yakaman, 2010)

so according to John Dewey only through context learning learners get real understanding (Milara & Cortés, 2019). STEAM learning supports the transition from traditional learning to strategic and project-based learning as well as collaborative learning (Milara & Cortés, 2019). Research data also showed that as many as 45% of teachers implement STEAM learning by collaborating on the Discovery Learning learning model. (DL). Discovery Learning has applied STEAM-based collaborative learning in the classroom showing that learning practiced by teachers has already led to STEAM learning. In addition, the ability to collaborate is also one of the goals in STEAM learning. (Quigley & Herro, 2016).

Challenges of Implementing STEM Education in West Java's Elementary Schools

Steam learning with all its benefits, of course, is not out of the challenges in its implementation process. Based on the results of the research showed the challenges of implementing STEAM learning in primary schools in Western Java, namely pedagogical aspects, facilities for support, access to content, and timing.
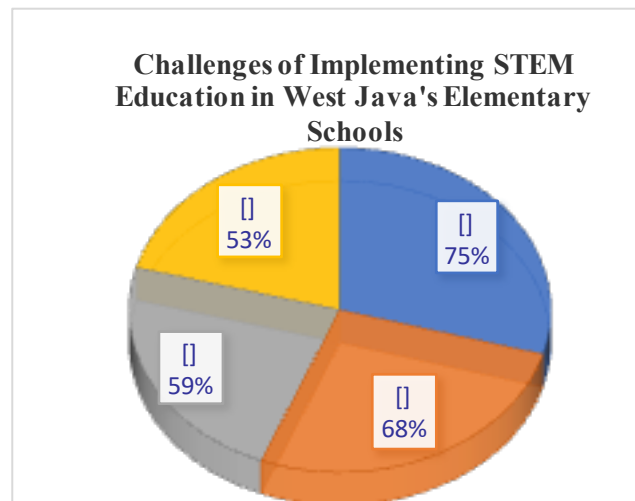

Figure 2.

The availability of facilities in support of the implementation of STEAM is approximately 75%. These barriers include the availability of computers, the Internet, and less adequate projectors for use in the STEAM learning process. The availability of technology-based facilities has become one of the important factors in STEAM learning. Technology is needed by both students and teachers to be able to access information related to STEAM learning more easily. This is also in line with the results of research showing that the IT-based learning facilities available in schools influence the learning outcomes of students. The skill of students in using technology is also one of the forms of integration of technological aspects in STEAM learning. The definition of technology in STEAM learning by the National Council of US (Bahrum et al., 2017) consists of the entire system ranging from the people involved, organizations, knowledge, processes, and devices used to create and operate the technology tool as well as its own. Thus, it can be understood that the aspect of technology is not just something related to electricity. Technology can be the skills of the students in using the tools and also the products produced by the students themselves. In addition to technology facilities, teachers revealed that the availability of school facilities is one of the challenges in the implementation of STEAM learning. These facilities include interactive media and furniture in less adequate classrooms. Teachers feel less available media ready to use that can be used to support learning (Rafiqa et al., 2020).

Another challenge perceived by teachers in the implementation of STEAM learning is the support of knowledge about the less adequate of 68%. This includes the lack of pedagogical models on how to teach STEAM attractively. In line with a statement by Shernoff et al. (2017) that revealed the lack of STEAM learning given to teachers and teachers also felt a lack of training on STEAM Learning. One teacher revealed that the STEAM training provided by the government tends to focus only on theory. In addition, 59% of teachers also encountered challenges in accessing STEAM content. These challenges include administrative, budgeting and availability of STEAM content in Indonesian. The data suggests that one of the challenges in STEAM learning is the lack of teaching resources about the application of STEAM in elementary schools. Previous research also revealed that a lack of resources such as facilities, budgets and access to content (Shernoff et al., 2017) is one of the challenges of STEAM implementation perceived by teachers.

Time settings are also a barrier in STEAM learning. 53% of teachers in Western Java experience time constraints in the application of STEAM teaching. This is because STEAM learning focuses on hands-on activities so that teachers need to have practical activities in the learning process. The results are also consistent with previous research that revealed that one of the challenges in implementing STEAM learning included time and time planning issues in the implementation of STEAM Learning. (Herro et al., 2019; Shernoff et al., 2017). The government has provided STEM/STEAM training to teachers. However, many teachers argue that STEAM training is especially helpful in providing insights into project-based learning and problems that can be implemented in STEAM learning. However, some teachers argue that the training provided is still theoretical so it still has challenges in the technical problems of the implementation of STEAM. (Herro et al., 2019; Shernoff et al., 2017).

Conclusion

The education provided by the instructor has led to STEAM education. This is evidenced by the comparatively high proportion of teacher data indicating the implementation of student-centered learning. Teachers also employ inquiry, project-based learning, and problem-based learning methods. Several obstacles exist in the implementation of STEAM learning, including a lack of pedagogical support and understanding, technical issues, time, access to STEAM material, and infrastructure, particularly technology-based facilities. Teachers most typically cite technical and time constraints as obstacles to STEAM adoption. Therefore, instructors require training in methodologies and time management for the application of STEAM education. In addition, it is vital to offer supporting facilities, particularly technologically-based facilities that facilitate instructors' access to STEAM-related instructional materials.

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