Introduction of STEAM for Preparing Innovative Elementary Teachers in Science

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Abstract. 21st-century competence was always been a concern in this era. It was very important to full fill student and teacher competence. It is called 4Cs, namely creative thinking skills, critical thinking skills, communication skills, and collaborative skills. There was one of the learning that in accordance with the 21st century, was STEAM (Science, Technology, Engineering, Arts, and Mathematics). Before preparing students to gain this competence to introduce STEAM, it is important to needed preparing for innovative teachers soon in university or lecturers about STEAM. One of the lecturers in PGSD was called Learning Plan in Elementary or "Perencanaan Pembelajaran SD" which introduced STEAM in science and its implementation of it. The objective of this research was to know the capability of college students to prepare and practice STEAM in science matters. It used the descriptive quantitative method by the percentage of identifying implantation STEAM in science matter. 35 College student of PGSD as a subject of this research was taking Learning Plan as Elementary lecturer. The result shows that about 80% of college students have been planning STEAM as evidenced by designing STEAM and practicing teaching aids. It can be concluded that introducing STEAM for a college student can be applied to innovative teachers soon.

Keywords: STEAM, 21st century competence, 4Cs, Science, Innovative teacher.

How to Cite: Wardani, Rizki P. & Fitriyah, Chumi Z. (2023). Introduction of STEAM for Preparing Innovative Elementary Teachers in Science,. *Proceeding The 5th International Conference On Elementary Education*, 5(1). 552-558

INTRODUCTION

Teacher was required to be innovative and creative to achieve for full fill student competence today. 21st-century learning currently emphasizes 4C competence, there were critical thinking, creative thinking, collaborative, and communication skills in students. It includes for improving quality of education that suitable with 21st needed. It called 21st competence, whereas these skills are able to growing, increasing, and train students' soft skills (Septikasari & Rendy Nugraha Frasandy, 2018).

The ability to think critically, be creative, communicate, and collaborate is a 21st-century skill expected by the government. In addition, the level of information literacy, creativity, innovation, media literacy, technology, adaptability, and flexibility, as well as social and cultural interaction is also expected to be achieved (Archambault et al., 2010; Fajri et al., 2020; Rayna & Striukova, 2021; van Laar et al., 2020). For preparing students with these abilities, good learning planning is needed and supports this, one of which is using STEAM taught by the teacher.

STEAM is the same as the STEM model, but only differs in the Art aspect. STEM includes Science, Technology, Engineering, and Mathematics. The STEAM program can include performing arts such as dancing, design, drawing, photography, and writing in a lesson given in project assignments to students. STEAM learning is currently in accordance with the 2013 curriculum that has been running, and it is undeniable that it can also be implemented in the Kurikulum Merdeka. The implementation in Indonesia is a preparation to achieve capabilities in the 21st century. Integration of STEAM in Education integrates science, technology, engineering, arts, and mathematics that are designed creatively to apply scientific abilities (Kim & Kim, 2016).

Implementation of STEAM carried out by the teacher is directed at project-based learning, which will integrate all aspects of STEAM into learning. In contrast to traditional learning, teachers use STEAM to integrate disciplines between aspects of science, technology, engineering, art, and mathematics (Ng et al., 2022). STEAM is the basis for learning methods so that in the learning process it teaches skills that refer to the development of a comprehensive world of technology.

Future teachers are expected to have innovations in lesson planning to support 21st-century abilities and skills. To prepare innovative teacher candidates, in one of the courses an introduction to STEAM is given to PGSD students who are prospective elementary school teachers, which is very important and provides information and benefits for the future. In one of the elementary learning planning lectures, students are given STEAM introduction material which is expected to provide STEAM insight and design learning and project-based media. Based on Pasani's research, project-based learning can improve 21st century skills(Pasani & Amelia, 2021).

One of the five aspects of STEAM is science. Based on research (Nuraini & Muliawan, 2020) students show an interest of 95% when studying science, because it relates to problems and the surrounding environment. STEAM learning provided on a project basis to students is able to make students more active and creative, as well as increase creativity in solving problems and creating products that have benefits (Nasir et al., 2019). Science not only learns the concept but also masters the process skills. With the implementation of project-based STEAM, students will have a better understanding of the material and their skills will be achieved (Setiawan et al., 2021).

STEAM is the basis for the learning methods used by today's innovative teachers which refer to the development of comprehensive skills. The purpose of this study is to provide an overview and insight for PGSD students to be able to implement STEAM in elementary school classes

METHOD

The research was conducted using a quantitative descriptive method. The research subjects were 35 semester IV PGSD students at the University of Jember. The data was collected using an observation instrument regarding the implementation of STEAM on student projects. The observation instrument consists of statements and indicators regarding STEAM.

Table 1. Indicator of STEAM

Aspects	Description
Science	Engagement includes understanding and applying natural phenomena and social behavior situations using systematic methodologies, and based on evidence through observation and experimentation;
Technology	Modification regarding technological innovation in meeting human needs and desires and solving problems;
Engineering	Kknowledge and skills to design and construct machines, systems, materials, and processes that are beneficial to humans economically and environmentally friendly;
Arts	Creating project results so that they have beauty in terms of art and creativity;
Mathematic	all about patterns, relationships, numbers, quantity and space and provides the language for technology, engineering and science.

Observation results are used to analyze data on STEAM implementation. The score results from collecting questionnaire data are then calculated by using this formula :

$$P = \frac{f}{N} \times 100\%$$

Information:
P : Percentage number
f : Raw score obtained
N : Highest score in the questionnaire

Table 2. Score Intepreatition of STEAM

Percentage (%)	Category
0 – 20	Very less
21 – 40	Less
41 – 60	Enough
61 – 80	Well
81 – 100	Very well

(Riduwan, 2015)

RESULTS

The research results regarding the introduction of STEAM to PGSD students, the results are represented in the graph as follows:

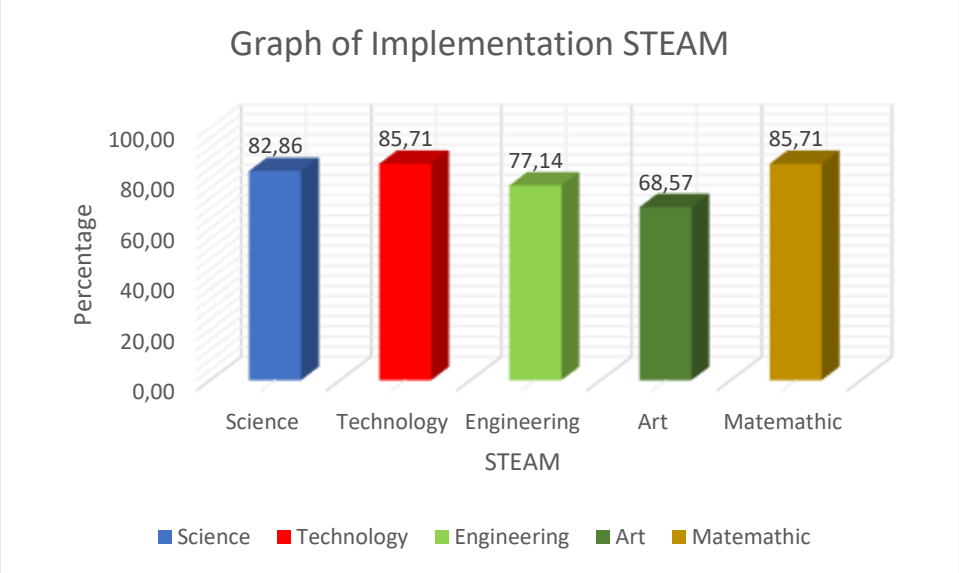

Figure 1. Implementation of STEAM

It can be seen from the graph above, the implementation of STEAM in the elementary school learning planning course regarding making STEAM projects was obtained for Science implemented at 82.86% in the very well category, Technology at 85.71% in the very well category, engineering 77.14% in the well category, 68.57% in well category, and Mathematics 85.71% in very well category. Of the five indicators in STEAM, an average of 80% is obtained with well criteria.

DISCUSSION

This research to describe the ability of PGSD students in designing STEAM learning in the future to become innovative teachers through a project. The first step in this research is to introduce students to STEAM learning and the meaning of each indicator. STEAM learning supports 21st century skills, where there are 4c that is required, namely critical thinking, creative thinking, collaborative skills, and communication skills. A project made by students can improve their ability to analyze problems to make creative solutions as well as develop the skills needed in the 21st century (Supriadi, 2019). STEAM learning in an integrative manner refers to a learning approach that intentionally integrates the concepts and practices of science, art, and mathematics as well as technology. An approach of using one or more teaching technologies to teach science, art, or mathematical concepts and practices consistent with operational definitions (Sanders, 2008)

This introduction to STEAM learning is given in the Elementary School learning planning course. One of the CPMK of SD learning planning is creating innovative learning tools. One of the innovative learning that is predicted in the 21st century through STEAM. The initial step of this

learning is to provide knowledge of the meaning of STEAM, its indicators, and examples of its application in learning. It is hoped that prospective teacher students can take advantage of STEAM learning in elementary schools because the implementation of STEAM in schools is able to make students interested in learning. Accordance to research in 2015, that STEAM makes students interested in every lesson and increases creative abilities according to 21st century competencies ((Aldemir & Kermani, 2017). At the end of the lecture, a kind project was given to develop STEAM-based media for elementary school students. This project activity is able to increase students' critical abilities and collaboration (Sulistyarini et al., 2019). Educators are tasked with giving direction and attention to the process when students make projects during ongoing learning (Mustofa & Hidayah, 2020).

The first step in the introduction of STEAM learning is to identify the problem. Problems raised in learning must be adapted to the basic competencies in learning and raised according to real conditions. This activity asks students to think critically about the phenomena raised according to the material. The consistency of activities for critical thinking in a phenomenon will create a society that is active and aware of the problems around it (Jayadiputra & Suparman, 2019). Creative thinking skills also play a role in this matter to provide innovative solutions. One of the problems that students took up was building a bridge to help when there was a flood in the area. This material is included in the science material regarding natural resources.

In the second step, students choose the problems that have been studied in the previous step. Students work together to determine the problem and why it is important to raise or solve it. The implications of this stage later, when students become teachers, will lead students and train students to think critically, and creatively, and communicate smoothly with others. The next step is to collect information from books, journals, or other sources related to the problem that has been selected. After searching for information through various sources, students are then asked to make a STEAM-based project design. The final step displays how the project works and the lecturer gives an assessment according to the STEAM indicators.

Some of the results of the STEAM project have been videotaped by students. The project results from students in the form of STEAM-based media are as follows :

Figure 1. Swing Bridge

Figure 2. Cars Air Power

Figure 3. Water Well

From the projects that have been made by students regarding the STEAM Project, the implementation of STEAM has been presented in Graph 1. The linkages between Science, Technology, Engineering, Arts, and Mathematics are integrated with one another in learning. Of all the determining STEAM indicators, the Arts indicator gets the lowest percentage of 68.57% but is still categorized as high according to the interpretation table. From the Arts side in STEAM students are asked to provide a creation that has artistic value, this can be based on creativity. Arts in the STEAM project can visualize students' understanding later (Smith & Samarakoon, 2014). Based on research (Aldemir & Kermani, 2017) students learn actively with various materials that attract their attention.

Science in STEAM which is carried out by students is not based on natural science material alone, but activities that involve understanding and applying phenomena and social behavior using a systematic methodology, based on evidence through observation and experimentation. Research from (Kewalramani et al., 2020) reports that STEAM learning supports scientific inquiry, design of thinking, and creativity. This includes the Science indicator on STEAM.

The understanding of technology in STEAM is not always digital-based. There is a connection between technology and engineering. Research from (John et al., 2018) indicates that tools designed for STEAM learning also represent engineering problems. Some PGSD students use technology by modifying it, such as making windmills and making minimalist flashlights. The engineering indicators in STEAM focus on students' experience in developing science processes and the ability to assemble tools (Tippett & Milford, 2017).

Innovative teachers are a challenge for Education today. Integrating STEAM learning activities help shape a student's way of thinking to connect several abilities and skills (Hassan et al., 2019). But the limited understanding of STEAM by teachers is still limited. However, from this research, it can be said and explained that elementary school teacher candidates already know the meaning of STEAM learning which is expected to become an innovative teacher.

CONCLUSION

The introduction of STEAM learning in the field of science is very useful for prospective elementary school teacher students who integrate several abilities, namely Science, Technology, Engineering, Arts, and Mathematics. Making STEAM-based media projects shows that students have been able to design media used in learning, where they have integrated all indicators. As many as 80% of students achieve the predetermined indicators. With this kind of introduction, students are expected to be able to provide space for their creativity in designing STEAM learning, and to become innovative teachers, as well as to produce students who achieve 21st century skills.

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