STEAM Implementation Analysis on Creative Thinking Skills of Middle School Students in East Java

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Abstract
The Covid-19 pandemic impacts each sector of life around the world, including the education sector namely, changes in the implementation of education. This impact is related to the implementation of learning that switches from online to offline. Students feel passive when learning offline. Science learning emphasizes that students should be active in STEAM project assignments. However, there is no research description of the application of STEAM learning in East Java after the pandemic. This study aims to describe East Java's STEAM implementation of creative thinking skills. STEAM is an integrated approach that combines science, technology, engineering, art, and mathematics as a means of developing student inquiry, teamwork, creative thinking skills, critical thinking, and other skills during learning. This research methodology uses qualitative descriptive research. Research instruments are in the form of interviews, literature studies, and field observations. Data analysis techniques include data reduction, data display, and drawing conclusions on verification. The subjects of this study were 30 middle school teachers from East Java. The results of the study show that the application of STEAM education to creative thinking skills has a positive impact on education in East Java, Indonesia. The results of this study are expected to add insight to the teachers in learning science innovation with STEAM education.

Keywords: STEAM, Creative Thinking Skills, Middle School, East Java

Introduction

The Covid-19 pandemic has had a major influence on global change, one of which is in the field of education. During the pandemic, Indonesia conducted learning online. The teacher provides learning materials using online learning application features. Students get material taught by the teacher online by using the application suggested by the teacher. Students do learning in their homes. When the covid-19 pandemic is over, learning returns to normal as before. Face-to-face learning at schools is permitted while adhering to health protocols. Face-to-face learning that is carried out again becomes a challenge for teachers to deal with students who are used to the virtual world. Learners tend to be less active in interacting both with friends and with teachers. The transition from online to offline learning is a challenge for teachers.

The rapid development of science and technology had a major impact on the industrial revolution. Education is a very important aspect as a basis for sustainable development (Alenezi, 2020). One of the important elements that can grow the economy and national competence in the current era is preparing several learning system innovations and improving the quality of competence of graduates who have learning and innovation skills in the 21st century. 4C is an attitude that needs to be developed in the 21st century. 4C is the development of an attitude which consists of critical thinking, creative thinking, collaborative, and communication. 4C can be implemented when teaching and learning takesplace (Supena et al., 2021). The application of 4C abilities can make students think coherently. This research focuses on the ability to think creatively. One of the subjects studied by students is natural science education.

Natural science education is a science with the topic of discussing natural phenomena which are arranged systematically based on the results of experiments and observations (Hamza et al., 2022). Science learning includes knowledge in the form of facts, concepts and principles obtained from experience, as well as the result of a series of processes through investigation, preparation, and presentation of ideas (Jannah & Atmojo, 2022; Nurmala et al., 2021; Pratiwi et al., 2022). Science learning is closely related to the natural potential that is in the environment around students. In addition to studying natural forms theoretically, students also learn the blessings of gratitude for the creation of the almighty.

Based on the characteristics of science learning can be applied using the STEAM approach. STEAM is a disciplinary approach with a combination of the fields of science, technology, engineering, art, and mathematics. STEAM is able to develop students' abilities as a means of investigation, communication, leadership, teamwork, creativity, critical thinking and other skills in learning (Rodríguez-Nieto & Alsina, 2022; Starzinski, 2017; Zubaidah, 2019). The STEAM approach is needed to nurture convergent creative talents in students to lead the future with the development of science and technology (P. W. Kim, 2016). The STEAM approach is an effective educational strategy for solving problems faced by students (Park et al., 2016).

The STEAM approach is based on basic concepts that make students understand the material content in depth (Jho et al., 2016). STEAM implementation in schools needs to be improved in order to achieve learning objectives. Based on data in the field, it shows that the implementation of STEAM in several schools in Indonesia has resulted in specific improvements in 21st century learning, namely communication skills, critical thinking, creativity, and collaborative skills (Asti & Andriyani, 2022; Mu’minah & Suryaningsih,

2020). Learning outcomes with the STEAM approach can increase student creativity through project learning (Nurinayah et al., 2021). Identification of the application of STEAM learning in Indonesia, especially in East Java, has not been specifically explained. Therefore it is necessary to have a detailed and complex descriptive analysis to find out the results of the implementation of STEAM learning in East Java, Indonesia.

Method

This study uses a qualitative descriptive model. The data were obtained based on the results of interviews with 46 middle school science teachers in East Java, field observations, and literature studies. Interviews were conducted with science teachers in junior high schools in East Java by discussing the implementation of STEAM in science lessons that have been implemented. Field observations were carried out by researchers by making direct observations of students' work when developing creative thinking skills in STEAM learning. Literature study is used as a support for research data that has been developed. Data analysis techniques use the Miles and Huberman model. Activities in data analysis are data reduction, data display, and drawing conclusions (Creswell, 2012). Data analysis was carried out to find out the implementation of STEAM in the East Java region.

Results

Based on data analysis, the results of the correlation between STEAM learning and creative thinking abilities were obtained are found in Table 1.

Table 1. Correlation between STEAM Learning and Creative Thinking Skills

Syntax STEAM Approach	Fluency	Flexibility	Originality	Elaboration
Formulation of the problem	√	√		
Design problem solving		√		√
Creating and developing models			√	
Using models	√	√		
Evaluation				√
Communication and reflection				√

Discussion

Implementation of Science Learning using the STEAM Approach

STEAM is an integrated approach that combines several aspects, namely science, technology, engineering, art, and mathematics (Rodríguez-Nieto & Alsina, 2022). Science learning with the STEAM approach can train students' independence in acquiring knowledge with discovery-based learning based on their knowledge. The STEAM approach is an effective educational strategy for solving problems faced by students (Park et al., 2016). The STEAM approach is based on basic concepts that make students understand the material content in depth (Jho et al., 2016).

Based on the research data, it shows that the implementation of the STEAM approach in East Java has been well implemented. Teachers have an organization, namely the science subject teacher deliberations in each region. The applicable curriculum in Indonesia emphasizes active students in learning. The application of STEAM learning to science material is emphasized on project performance that has been planned by the curriculum. The

implementation of STEAM learning has been applied magnetism, electricity, biotechnology, inheritance, temperature, environmental pollution, gas pressure, simple machines, acids and bases, motion and force, heat, wave and sound vibrations, genetics, the solar system, changes in matter, systems circulation, newton's laws, photosynthesis, and the respiratory system. The teacher acts as a facilitator if there are students who experience difficulties both theoretically and practically.

Definition of STEAM according to the teachers is an approach that emphasizez student competence by combining the five disciplines of science, technology, engineering, art, and mathematics to solve a problem. Students produce project learning that is associated with STEAM learning on science material. The results of students' project performance on science learning which is linked to the STEAM approach produce an assessment of aspects of creative thinking skills.

The implementation of STEAM learning based on the data obtained emphasizes student project performance. In the project students are trained in integrating several aspects of STEAM. Project activities take place with the integration of science material with other aspects such as technology, engineering, art, and mathematics. The teacher conceptualizes students by explaining important things that students need to understand. STEAM learning is implemented with learning models such as project based learning, discovery learning, and others.

Based on the research results also show that there are several schools that have not implemented STEAM learning. This is due to constraints from inadequate school facilities and teachers who have not received intense training on STEAM learning. The teacher has implemented practicum activities, but has not been integrated with the existing concepts in STEAM learning. The implementation of STEAM learning in schools can be used as an innovation in science learning for middle school students.

The Work of the Science Learning Project with the STEAM Approach to Students' Creative Thinking Skills

The STEAM approach is a modification of the STEM (Science, Technology, Engineering, and Mathematic) approach implemented by the National Science Foundation (NSF) in the United States (B. H. Kim & Kim, 2016; P. W. Kim, 2016). Departing from the teachings of neuroscience which tries to balance between the working of the left brain and the right brain in learning science. In the STEAM aspect there is an additional "art" component which is learning arts and humanities. Art knowledge is proposed as an interesting and realistic learning based on experience resulting from integration with scientific disciplines and can encourage creativity and problem solving (Herro et al., 2017). In the artistic aspect, you can learn about design, where creative thinking processes can be trained to explore aesthetic elements and the use of goods in everyday life. Arts can help students make connections between concepts and ideas by supporting the assimilation and accommodation of new ideas into the scheme of learning materials. The ability of the right brain, left brain, and body to work together produces higher cognition than is produced from just one process (Hughes et al., 2022).

The ability to think creatively is a process that enables students to find connections, face new challenges, and seek unusual, original, and new resolutions (Gafour, 2021). Students can do learning by discovering new things based on individual perspectives that have been packaged

at the time of discovery both theoretically and practically. Indicators of creative thinking ability used as a benchmark in this study are fluency, flexibility, originality, and elaboration (Alghafri & Ismail, 2014; Gafour, 2021; Sola et al., 2017). Each indicator of the ability to think creatively produces data that is analyzed in the study. The research data shows that students are very enthusiastic in participating in learning by implementing the STEAM approach.

Schools that apply the STEAM approach relate to project outcomes linked to indicators in creative thinking skills. The first indicator is fluency, students are able to relate/connect existing problems in learning with real life experienced in the surrounding environment based on literature studies. The second indicator is flexibility, students have started to be responsive and active with the existing problem conditions in the surrounding environment. The third indicator is originality, students have been able to find new discoveries at the time of project discovery. It was evident from during the process, they held discussions with their group mates to find the best solutions and results. The fourth indicator is elaboration, Students have made different works based on project assignments.

Students with the application of STEAM learning produce project works that can be assessed aesthetically, neatly, and beautifully. Based on the observation data, it was found that the results of students' work with various innovative levels of creative thinking with an assessment of aspects of beauty, neatness, and aesthetics. STEAM works can be used as teaching materials to achieve meaningful learning. The work of students is also produced from the utilization of used goods. Students are taught to apply STEAM learning that cares about the environment by utilizing used materials as material for project assignments. STEAM learning takes place by training students to learn actively and teachers as science learning facilitators.

Correlation Between STEAM Learning and Creative Thinking Skills

STEAM-based learning uses EDP (Engineering Design Process) terminology. STEAM learning can be correlated with indicators of the ability to think creatively. The EDP flow is a formulation of the problem, designing problem-solving, creating and developing models, using models, evaluation, communication, and reflection. At the problem formulation stage, students are able to summarize answers and generate ideas that are included in indicators of fluency in creative thinking skills. At the problem formulation stage, there is also a relationship with the flexibility indicator because it trains students in connecting with situations, manage situations, and plan different answers. At the design stage of solving problems related to flexibility indicators, namely, students can find solutions to problems by providing perspectives on situations, organizing situations around them into STEAM learning, and finding several solutions to problems around the students' environment. At the problem-solving design stage, there is also a relationship with the elaboration indicator. This is because students when designing problem-solving require collaboration with group mates to exchange opinions based on the theory they have obtained.

The next syntax, namely creating and developing models related to indicators of the ability to think creatively on the aspect of originality. Creating and developing models trains students' ability to produce new work. At this stage, students are also able to modify a work according to the abilities and knowledge they understand. In the using model stage, it relates to indicators of the ability to think creatively, aspects of fluency, and flexibility. The fluency aspect trains students' ability to summarize answers and generate ideas. This can make

students fluent in generating ideas when modifying or creating a project model that will be produced. The flexibility aspect is able to train students' abilities when connecting with situations, managing situations, and planning different answers in making the work of project models that will be designed based on the performance of each group. The syntax for evaluation, communication, and reflection is closely related to the aspect of creative thinking skills, namely elaboration. The elaboration aspect trains students in differentiating ideas, planning to solve problems in a procedural way, and producing something new. The elaboration aspect is able to make learning more meaningful because students are active in discussing and exchanging ideas with group mates, classmates, and teachers.

The correlation between the STEAM approach and the ability to think creatively can be analyzed in Table 1. The correlation between sections shows that there is a relationship between the STEAM approach and the ability to think creatively. It can be concluded that learning that implements STEAM learning will be able to train students' creative thinking skills.

Teacher Obstacles in Implementing Science Learning with the STEAM Approach

Based on the data obtained, it shows that the teacher has implemented the STEAM approach in learning science. There are several schools that experience problems in implementing STEAM in science learning. First, constraints due to limited time available. STEAM learning requires a relatively longer time, so the teacher allocates optimal time for its application. Second, constraints related to facilities and infrastructure. Third, conditions students when learning about high order thinking skills. There are several schools that have limited equipment, so learning project assignments is not possible.

Conclusion

Based on data obtained from interviews with middle school teachers, field observations, and literature reviews, the results of an analysis of the implementation of STEAM learning for students were obtained. The data results show that middle school teachers in East Java have implemented STEAM learning. The teacher assesses STEAM learning with a disciplinary focus on students' creative thinking skills. STEAM learning is able to train students to think creatively. In line with this research, there are also obstacles in implementing STEAM learning, namely several schools are still constrained by limited facilities and infrastructure, as well as the distribution of limited study hours when implementing STEAM learning.

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