

LEARNING WITH AN INTEGRATED STEM PROJECT BASED LEARNING MODEL TO IMPROVE STUDENTS' CREATIVE THINKING ABILITIES

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ABSTRACT

Learning using the STEM integrated project based learning model in the 21st century is widely applied in schools, so researchers want to create a literature review for this title. This research uses a systematic literature review method, namely collecting several articles that match the title being studied. Based on the literature selection process (prism method) that has been carried out, it is known that the literature search results (identification) total 3 pieces of literature, 489 pieces of literature sourced from Google Scholar and 352 pieces of literature sourced from Crossruff. The results of this research show that the average N-gain value in the experimental and control classes has a significant difference so that the data obtained is high enough to improve students' creative thinking abilities.

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1. INTRODUCTION

We are currently in the 21st century, which is a century with very rapid developments in science and technology almost throughout the world or globally. This triggers an increase in competition or very tight competition between countries which has an impact on globalization in the world. To be able to compete in the 21st century, new skills are needed which are called 21st century skills. 21st century skills can be trained through education (Weng et al., 2022). Educators and students expand their abilities with technology to improve the quality of their future careers and social life. The skills training provided is 4Cs (the skills of critical thinking, communication, collaboration, and creativity). The term 4Cs can be interpreted as 4 21st century skills, including (critical thinking skills, communication, collaboration, and creativity). In this rapidly changing world, creativity is one of the things that determines a person's excellence (Yigletu et al., 2023).

Individual success is determined by their creative ability to solve problems, both large and small scale (Hytti & O'Gorman, 2004). The importance of aspects of creativity for human survival has made the study of creativity an important topic for various groups, from public policy makers, scientists, researchers, to practitioners. However, creativity data in Indonesia is still relatively low, this can be seen from the results of The Global Creativity Index in 2015. Indonesia was ranked 115th out of 139 countries (Karim, 2017).

Creative thinking skills play an important role in the learning of all students and are part of the higher order thinking skills that need to be developed. Creative thinking has little attention in science learning (Caetano & Zaro, 2018; Sunaringtyas et al., 2017; Yosopranata et al., 2018). However, when students pay

attention to the learning process, creativity will increase understanding and encourage students' cognitive development. Students need to explore their creative potential to face various contextual problems, which require reasoning, argumentation, and creative thinking skills. Both critical and creative thinking skills are essential to achieving science learning goals (Saputra et al., 2021; Umar et al., 2020). These skills must be cultivated and nurtured. More meaningful science learning allows students to ask questions and express their ideas. Realizing the importance of creative thinking skills, teachers must develop teaching instructions that can help students to improve their higher order thinking skills in science learning.

One of the right ways to increase creative thinking is to involve students in experiential activities that encourage active exploration through the integration of an interdisciplinary curriculum and orientation towards open and diverse subjects (Chen et al., 2020). STEM-PjBL (Project-based Science, Technology, Engineering and Mathematics) based on constructivist teaching theory, integrating interdisciplinary knowledge of science, technology, engineering and mathematics through project-based learning strategies; provide students with learning situations where they can actively explore real-life experiences and design solutions to real-life problems to foster creative thinking and hands-on skills; adopt diverse evaluations so that students can give full play to their talents; exposes students to science and technology related to engineering; and allows students to connect their classes with the real world (Kefalis & Drigas, 2019; Kokotsaki et al., 2016; Thuan, 2018; Wahono, 2020).

To develop creative thinking skills, students must be given the opportunity to develop creativity by doing as much work as possible in learning. One learning model that can provide maximum opportunities for students to explore their creativity is PjBL (Project Based Learning) learning (Kartika, 2020). Examples of the advantages of PjBL (Project Based Learning) learning include that it can increase motivation, can improve problem solving abilities, can increase collaboration, can improve resource management skills, and Increased resource - management skills, apart from that PjBL can improve critical thinking skills, creativity, skills. creative thinking and student achievement. And one way to solve the learning problems described above is with the STEM (Science, Technology, Engineering, Mathematics) approach. STEM is suitable for creativity, because the engineering process is a process of training creativity. Referring to the problems above, the aim of this research is to describe the influence of STEM-PjBL learning on students' creative thinking skills.

2. RESEARCH METHODS

This research uses the SLR (Systematic Literature Review) method with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analysis) model. The steps in the prism method are formulating a formulation (identification), systematic literature search (*screening*), filtering or selecting articles that are deemed suitable to the researcher's title (*eligibility*) and analyzing articles that have been selected (*included*) (Savec & Mlinarec, 2021; Zarate et al., 2022). The formulation in this research is as follows.

1. Search formulation

Data Base	Search Series
Google Scholar	Project Based Learning OR Project Based Learning OR PJBL AND STEM OR STEAM OR STREAM AND Creative Thinking OR Creative Thinking OR Creative skills
Crossref	Project Based Learning OR Project Based Learning OR PJBL AND STEM OR STEAM OR STREAM AND Creative Thinking OR Creative Thinking OR Creative skills

The search formula uses the publish or perish application, namely article data sourced from Google Scholar and Crossref. A search for research literature relevant to this research topic was carried out. This search for Google Scholar has a maximum of 1000 data and for Crossref 100 data also with years from 2018-2023.

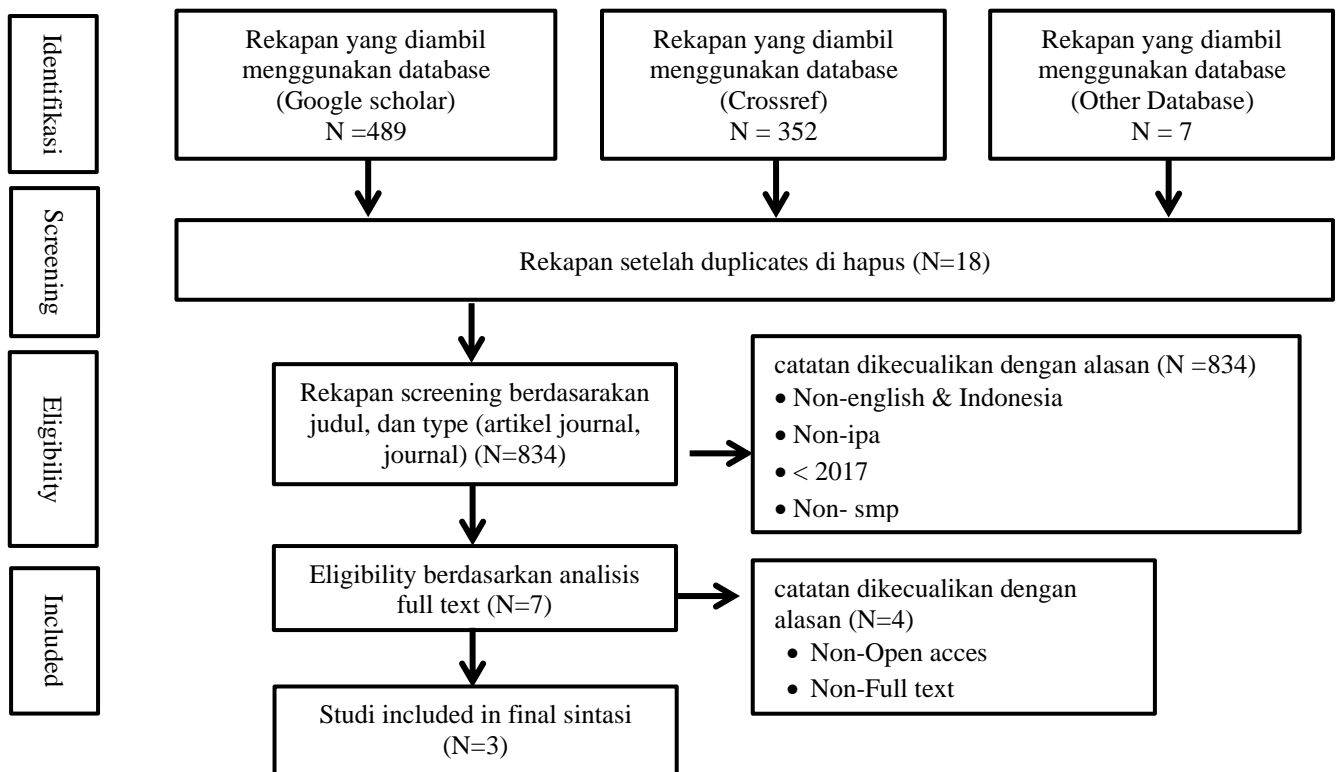
2. Inclusion/ Exclusion Criteria

Criteria	Eligibility/Inclusion	Exclusion
Literature	Journal article	Systematic Review, Book, Chapter in Book

Language	Indonesian, English	Apart from Indonesian and English
Time	2018-2023	<2018
Subject/material	Science Learning	Mathematics, crafts, arts and culture, social sciences, history, civic education
School	Elementary, Middle School, High School	Students & non-students
Open Access	Full text	Just abstract

Inclusion criteria are the general characteristics of research subjects from an accessible target population to be studied, while exclusion criteria are eliminating or excluding subjects who do not meet the study inclusion criteria for various reasons. There are several inclusion/exclusion criteria that need to be considered when collecting Systematic Literature Review (SLR) data. Such as literature, language, time, subject/material, school, and open access. The inclusions that must be fulfilled in writing this SLR are that the literature must be a journal article, the language used must be Indonesian and English, the period for publishing the journal is from 2018-2023, the subject and material that must be met is science material, the school criteria are elementary, middle and high school, and open access, namely full text. Meanwhile, the exception is that literature cannot use systematic reviews, books and chapters in books. Apart from Indonesian and English, it is not included in the criteria. Journals below 2018 cannot be included in the SLR data. Materials such as mathematics, crafts, arts and culture, social studies, history and PKN are included in the exclusion data. Other exclusionary data such as schools cannot use student or non-student data and open access cannot only be abstract. From the explanation above, in collecting SLR data, what must be fulfilled is the inclusion criteria, while what must be separated is exclusion.

3. Article Selection Flow (PRISMA Method)



3. RESULTS AND DISCUSSION

Based on the literature selection process (prism method) that has been carried out, it is known that the literature search results (identification) total 3 pieces of literature, 489 pieces of literature sourced from Google Scholar and 352 pieces of literature sourced from Crossruff.

After carrying out the identification stage, a screening stage was carried out to select the literature that had been obtained, 18 plagiarized literature was found so that the remaining literature was 832 pieces of literature. Then, articles were selected again that met the exclusion criteria, leaving 7 pieces of literature remaining. After the screening stage is carried out, the eligibility stage is carried out, namely the literature selection stage again so that literature is found that meets the inclusion criteria, and only 3 criteria are suitable for analysis.

Table 1. Articles analyzed

No.	Writer	Title	Method	Topics Learning	Sample
1	(Kornelia., Kristen., and Erawan., 2017)	The Effect of STEM-Pjbl Learning on Creative Thinking Skills	Preexperimental design	IPA	31
2	(Sukmawijaya et al., 2019)	The Influence of The Stem-Pjbl Learning Model on Students' Creative Thinking Abilities on Environmental Pollution Materials	Quasi experiment	Environmental pollution	21
3	(Supriyatin et al., 2023)	Steam-Pjbl Integration in Science Learning at Smp Negeri 3 Karangmojo, Bantul–Yogyakarta: Simple Microscope Project	Quasi experiment	Simple microscope	30

From the table presented, this research tends to use quasi-experimental research with varied subjects. The following is a table for calculating the n-gain on the results of the creative thinking ability test.

Table 2. Results of Students' Creative Thinking Ability Test Scores

Writer	Average N-gain	
	Experiment	Controls
(Supriyatin et al., 2023)	0.78	0.34
(Sukmawijaya et al., 2019)	0.71	0.47
(Kristiani et al., 2017)	0.75	0.35
Average	0.74	0.38

From table 2 the average value of N-gain shows that there is a significant difference between the experimental class and the control class. In the experimental class the average N-gain average is 0.74, based on the category, the ability to think creatively in the experimental class is included in the high criteria and in the control, class is included in the medium criteria, meaning that the ability to think creatively in students in the experimental class is better than in the control class. First, the research results show that there are significant differences between the experimental class which applies STEM project-based learning and the control class. The average N-gain value in the experimental class reached 0.74, while in the control class it was in the medium category. This indicates that STEM project-based learning has a positive influence on increasing students' creative thinking abilities, compared to conventional learning.

This observation is consistent with the theory which states that STEM project-based learning can improve students' creative thinking skills. STEM concepts enable integration between several scientific fields, which in turn encourages students to think holistically and see relationships between concepts in real-world contexts. Through projects that involve problem solving, exploration, and collaboration, students are given the opportunity to develop their creative thinking skills (Ibáñez, 2018; Osadchyi, 2021). Furthermore, data analysis shows that there is a significant difference between students' achievement of creative thinking skills before and after learning with STEM project-based learning. These results are in line with the theory which states that project-based learning encourages students to be actively involved in the learning process. Through relevant and meaningful projects, students are encouraged to explore, find solutions, and apply the concepts learned in real contexts (Petrov, 2020).

In addition, questionnaire data analysis also shows positive responses from students towards STEM project-based learning (Hinojo-Lucena et al., 2020; Villanueva, 2020). This is in accordance with theory which highlights the importance of meaningful and relevant learning for students. Project-based learning allows students to see the relevance of the concepts studied to everyday life, thereby increasing students' motivation and interest in learning. Integration between several fields of knowledge (mathematics, science, technology, and engineering) in STEM learning also provides students with a deeper understanding of the relationships between scientific disciplines (Duan et al., 2020; Glancy et al., 2017). This is in line with the theory that integrated learning can help students understand concepts comprehensively and contextually. Overall, the results of this study support the theory that STEM project-based learning has a positive influence on students' creative thinking abilities. Through this approach, students are given the opportunity to develop critical, creative, and analytical thinking skills, as well as social and collaborative skills that are important in facing real-world challenges. Therefore, implementing STEM project-based learning can be an effective strategy in improving the quality of learning in schools (Altmeyer, 2020; Lin et al., 2018).

Based on the results of research data analysis that has been carried out, it was found that the average achievement of students' creative thinking skills before and after learning with STEM project-based learning is significantly different, and the influence is large. This is supported by relevant research results, integrated learning in the STEM field has a positive influence on student learning achievement. The results of the questionnaire data analysis also showed a positive thing, that in general students felt that the learning being implemented was beneficial for them (Idrus et al., 2022). This is because in STEM project-based learning students are invited to carry out meaningful learning in understanding a concept. Students are invited to explore through a project activity, so that students are actively involved in the process. This fosters students to think critically, creatively, analytically. STEM project-based learning requires cooperation, communication between colleagues, problem solving skills, and self-management. STEM project-based learning helps students bridge the knowledge learned at school with the real world. The integration of several fields of science (mathematics with knowledge, technology, and engineering) in STEM project-based learning helps students understand that one field of science is closely related to other fields of science.

4. CONCLUSION

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method is a systematic research approach for collecting, reviewing, and synthesizing evidence from relevant literature. This approach allows researchers to organize data in a structured and objective manner, making it easier to analyze and interpret research results. In the context of this research, the PRISMA method is used to evaluate the effect of STEM project-based learning on students' creative thinking abilities. The research results show that the application of STEM project-based learning, especially STEM-Project Based Learning (PBL), has a positive impact on students' creative attitudes. This creative attitude is observed from the aspect of creative thinking, which is assessed before and after learning. A significant difference was seen in the increase in students' creative thinking abilities after participating in STEM-PBL learning, and this increase reached a large level. STEM project-based learning provides a learning environment that allows students to be actively involved in the learning process. Through relevant and meaningful projects, students are encouraged to explore concepts, find solutions to given challenges, and apply their knowledge in real contexts. This approach not only improves in-depth understanding of concepts, but also stimulates student creativity. The theories that support the results of this research highlight the importance of meaningful and contextual learning for students. Project-based learning gives students the opportunity to see the relevance of the concepts studied to the real world, which in turn increases their motivation and interest in learning. In addition, the integration between several scientific fields (mathematics, science, technology, and engineering) in STEM learning allows students to understand the relationships between scientific disciplines holistically. Through STEM project-based learning, students are also invited to collaborate, communicate and solve problems as a team. This not only develops their social and collaborative skills, but also broadens their view of how science and technology can be applied in various life contexts. Thus, the results of this study support the idea that STEM project-based learning has a positive impact on the development of students' creative thinking abilities. By providing a challenging and relevant learning environment, this learning not only prepares students to face real-world challenges, but also gives them the tools and understanding necessary to become innovators and creative problem solvers. Therefore, the implementation of STEM project-based learning can be considered an effective strategy in improving the quality of education in schools.

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