Literature Study: Creative Thinking Skills Viewed from Students HoM in PjBL Model with STEM Approach

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Abstrak

Artikel ini membahas tentang hubungan antara kemampuan berpikir kreatif dengan *habits of mind* siswa dan model pembelajaran *project-based learning* dengan pendekatan STEM yang merupakan hasil studi literatur dari beberapa artikel terkait. Penelitian ini bertujuan untuk mengetahui bagaimana *habits of mind* berpengaruh terhadap kemampuan berpikir kreatif siswa didukung dengan model *project-based learning* dengan pendekatan STEM. Dari pengumpulan data beberapa referensi yang diterbitkan antara tahun 2014-2022, hasil studi menunjukkan apabila terdapat hubungan yang positif antara kemampuan berpikir kreatif dengan *habits of mind* siswa dan model pembelajaran *project-based learning* dengan pendekatan STEM. *Habits of mind* atau kebiasaan berpikir yang kerap digunakan siswa dalam proses pembelajaran dapat meningkatkan kemampuan berpikir kreatif mereka, sementara model pembelajaran *project-based learning* memfasilitasi siswa untuk mengembangkam kemampuan berpikir kreatif mereka melalui pengalaman belajar yang interaktif dan juga berpusat pada siswa, dengan menerapkan konsep STEM dalam kehidupan sehari-hari.

Kata kunci:

Kemampuan Berpikir Kreatif, *Project Based Learning, Habits of Mind,* STEM

Abstract

This article discusses the relationship between the ability to think creatively with the habits of mind of students and the project-based learning model with the STEM approach which is the result of a literature study from several related articles. This study aims to find out how habits of mind affect students' creative thinking skills supported by a project based learning model with a STEM approach. From the data collection of several references published between 2014-2022, the study results show that there is a positive relationship between the ability to think creatively and the habits of mind of students and the project-based learning model using the STEM approach. Habits of mind or thinking habits that are often used by students in the learning process can improve their creative thinking skills, while the project based learning learning model facilitates students to develop their creative thinking skills through interactive and student-centered learning experiences, by applying the STEM concept in everyday life.

Keywords:

Creative Thinking Skills, Project Based Learning, Habits of Mind, STEM

1. Introduction

One of the sciences that is often applied in everyday life is mathematics. Mathematics is also a compulsory subject that is always present at every level of education starting from kindergarten, elementary school, middle school, to university. Mastery in mathematics is a must, especially in the 21st century, which promotes creative thinking and technological advances. Partnership for 21st Century Skills in (Octaviyani et al., 2020) highlighting to

teach students 4 competencies that must be possessed in the 21st century, namely communicating and collaborating, critical thinking, and creative thinking. The purpose of learning mathematics is that students must be able to solve mathematical problems, understand the advantages of being systematic and using abstract thinking, and actively seek and find new ways to express mathematical situations and difficulties (Handayani, 2015)

As educators, we must pay attention to how important it is for students to develop their creative thinking skills from the school level (Noviyana, 2017). Learning mathematics requires the development of creative thinking skills so that students can obtain, handle and use information in order to survive in a competitive situation (Asriningsih, 2022). Cognitive skills, personality traits, education, family, community, and cultural factors are the main components of creative thinking. Students who have creative thinking skills can use their imagination to generate various ideas or concepts (Miliyawati, 2014). Habits of mind becomes a support for students in carrying out creative thinking activities to solve the problem difficulties presented. In the opinion of Costa in (Handayani, 2015) habits of mind refer to the qualities exhibited by individuals of high intelligence when they encounter problems that lack immediately apparent solutions. Habits of mind suggests that behavior requires a disciplined mind that is trained in such a way that it becomes a habit to try to continue to act wiser and smarter (Miliyawati, 2014).

The learning model that can help facilitate creative thinking skills and habits of mind is PjBL. The PjBL model also emphasizes the basic ideas and principles of disciplines that involve students in problem solving and other important tasks and encourages independent learning. This shows that the use of this strategy requires students to use creativity in many learning processes (Noviyana, 2017). In implementing the PjBL model in learning mathematics, it is necessary to combine it with the STEM approach in accordance with the demands of the Industrial Revolution 4.0 (Widana & Septiari, 2021). A country should establish an education system where students acquire Science, Mathematics, Engineering, and computer (Technology) knowledge, and produce products using the skills required in the sector to participate in the 21st Century (Ulfa et al., 2019). Learning with the STEM approach focuses on problem-based learning processes in real life using technology and mathematics. Learning with the STEM approach plays a role in forming human resources who can think critically, creatively, innovatively, communicate and collaborate (Rahmawati & Juandi, 2022).

In this article, the author analyses the existing explanation to illustrate how students' capacity for creative thought is regarded from the Habits of mind by implementing the PjBL model with the STEM approach. This study uses a STEM approach and the PjBL model to investigate how students' habits of mind affect their capacity for creative thought.

2. **Method**

This study employs a research method known as literature review, which involves gathering relevant data or sources pertaining to the topic under investigation (Habsy, 2017). This article uses a literature study according to Mardalis in (Hartanto & Dani, 2020) which can be reached by collecting previous research or other sources relevant to creative thinking skills in terms of habits of mind in the Project Based Learning model on

learning outcomes which are then combined to draw conclusions. The combined results of several previous studies are used to conclude: (1) how is the relationship between creative thinking skills and Habits of mind; (2) how is the Project Based Learning model with the STEM Approach; (3) how is the relationship between creative thinking skills and Habits of mind in the Project Based Learning model with the STEM approach.

The reading sources used are national journals, international journals, theses, and internet sites. Search for literature sources using online databases such as Google Scholar, ResearchGate, Garuda, and so on. The data analysis technique used includes 3 stages: First, organize, namely collecting and reviewing the literature that will be used in the article. Second, synthesize, which combines the results of the literature review into a unified whole. Third, identify, namely identifying problems that exist in the literature in order to get an interesting writing (Ismaya et al., 2018).

3. Results and Discussion

Based on the analysis of research data, it can be described as follows:

3.1. The relationship between creative thinking skills and HoM

The ability to think creatively is a category of higher order thinking. Creative thinking is the ability to produce or create something new with ideas that did not exist before (Sugiwati, 2022). The basic characteristics of creative thinking are showing potential in solving problems, arguing based on facts and having the emotional mental ability to complete tasks and responsibilities (Andrew Mamahit et al., 2020). The indicators of creative thinking skills are fluency is the ability to give advice in solving problems, flexibility is the ability to think flexibly, originality means the ability to provide unusual or unique responses, elaboration means the ability to develop ideas (Sumartini, 2022).

How to measure students' creative thinking abilities can be done by exploring student work that shows their creative thinking processes. It can also be based on what students communicate in writing or verbally, related to assignments, solving problems, or students' verbal answers to teacher questions, this is based on Worthington and McGregor in (Anindayati & Wahyudi, 2020). The ability to think creatively is always emphasized in the learning process at this time. The results of Bada and Olusegun research contained in (Nugroho et al., 2020) state that, in reality, the learning process rarely encourages students to think creatively. A problem is presented that requires students to respond and find solutions to any complex problems related to students' thinking, such as taking into account various ways to represent mathematical ideas, connecting ideas, making generalisations, and understanding mathematics in a structured way. This is done to encourage students to develop their creative thinking skills. Students are encouraged to solve difficulties using the habit of mind (Nugroho et al., 2020).

Habits of mind is a habit that is seen as having an influence on individual success. This is understandable because all forms of action taken by an individual are the result of his habit of thinking (Miliyawati, 2014). According to Lim & Selden in (Handayani, 2015), Habits of mind in general include recognizing patterns, experimenting, formulating, trying, creating, visualizing, and guessing. Habit of mind focuses attention on processes that involve students' thinking strategies so that effective learning occurs (Sumartini, 2022). According to Costa and Kallick, Habits of mind have 16 characteristics which refers to table 1.

Table 3. 1 HoM Characteristics according to Costa and Kallick

No.	Habits of mind	Characteristics
1.	Be firm	It's not easy to give up when faced with problems.
2.	Controlling impulsivity	Plan a strategy in action.
3.	Listen to the opinions of others with empathy	Accept opinions and input from others.
4.	Think flexibly	Think rationally and change perspective when looking at other ways.
5.	Metacognition	Understanding what is known and what is not known.
6.	Work carefully and precisely	Setting high standards and always striving to improve.
7.	Ask questions and pose problems effectively	Look for explanations and relevant information when asking questions.
8.	Apply past knowledge in new situations	Relate past experience to dealing with similar problems.
9.	Think and communicate clearly and precisely	Try to communicate verbally and in writing appropriately and carefully.
10	Make use of the senses	Utilize the senses of taste, touch, smell, hearing, and sight to estimate solutions.
11	Creating, imagining, and innovate	Have new ideas and ideas.
12	Eager to respond	Be curious and passionate.
13	Dare to take responsibility and take risks	Not afraid to fail and have considered everything.
14	humorous	Seeing the situation faced as an appreciation for others.
15	Thinking interdependently	Can collaborate with others in the team
16	Continuous learning	Keep trying to improve yourself.

The ability to respond with deliberate cues, thoughts, and tactics to create favourable results is a skill that may be acquired via understanding and use of the sixteen habits of thought (Handayani, 2015). In mathematics, HoM includes a person's habits in exploring mathematical ideas, asking questions, constructing examples, identifying problem-solving strategies that can be used, making generalizations, and re-examining work results (Asriningsih, 2022). Consistent and continuous habit in thinking HoM mathematically can foster mathematical disposition abilities in students such as critical, creative thinking skills, and or students' mathematical problem-solving skills (Miliyawati, 2014). Higher-order thinking skills are influenced by habits of mind. Individuals with strong habits of mind exhibit a high inclination towards mathematics and demonstrate

intelligent behavior. This is primarily due to the fact that habits of mind represent the pinnacle of learning outcomes, surpassing content knowledge, thinking skills, and cognitive abilities (Nugroho et al., 2020).

Habits of mind can help students to develop creative thinking skills and solve problems effectively. Habits of mind such as flexibility, reflective thinking, and lateral thinking can help students to solve problems creatively and generate new ideas. Several studies conducted in the 2014-2022 period show a close relationship between Habits of mind and the ability to think creatively. The results of the research conducted (Nurmeidina et al., 2022). Information obtained shows that most of the results of students' creative thinking skills tests show a relationship with students' habits of mind. Based on table 2, there are 2 people who can think creatively at a high level, one of which has a high HoM level. There are 12 people who can think creatively at a medium level who also have a medium level of HoM. There are 3 people who can think creatively at a low level and have a moderate level of HoM. The link between the results of students' creative thinking skills and habits of mind can be seen in table 2.

Table 3. 2 Comparison of the Results of the Ability to Think Creatively and the Habits of minds

Category	Creative thinking skills	Habits of mind
High	2	1
Medium	12	16
Low	3	-

This is also in line with the results of the study (Asriningsih, 2022), if students with higher HoM levels have the potential to have better creative thinking abilities. This is in line with the statement that the habits of mind have an impact on individual success. In research (Dwirahayu et al., 2017), shows that habits of mind affect students' mathematical abilities. In other words, every child has the habit of thinking within himself, so a teacher needs to explore and innovate learning, so students have the potential to develop their knowledge. In line with the research conducted (Sumartini, 2022) that HoM influences increasing students' mathematical creative thinking skills. Overall, the results of research in the 2014-2022 period show that Habits of Mind and creative thinking skills have a close relationship and influence each other.

3.2. PjBL model with STEM approach

The project-based learning model uses a process that is more student-centered and gives students a worthwhile educational experience. The project-based model's results provide the learning opportunities for concept development (Rahmania, 2021). In (Mawarni & Sani, 2020) states that this project-based learning model includes problem-solving activities, decision-making, investigative skills, and work-making skills. PjBL learning can increase motivation, can improve problem solving abilities, can increase collaboration, can improve resource management skills, besides that PjBL can improve critical thinking skills, creativity, creative thinking skills and student achievement.

STEM is a scientific field that is interconnected in some way. Technology and engineering are examples of applications of science, whereas science itself needs mathematics as a tool for data processing (Rahmania, 2021). The aim of integrating

STEM into the field of education aligns with the requirements of 21st-century learning, which emphasize the development of students' scientific and technological literacy. This is achieved through engaging students in activities such as reading, writing, observing, and actively participating in scientific endeavors. The objective is to enable students to enhance their existing competencies and effectively apply them in addressing real-life problems associated with STEM domains (Ulfa et al., 2019). The mathematical aspects of the STEM approach can indirectly develop creative thinking skills. Patterns of thinking, logic, and reasoning that are trained continuously can trigger students' creative thinking abilities (Widana & Septiari, 2021).

Students' creativity is cultivated through the STEM approach to solve challenges in daily life and to be able to reason and think critically, logically, and systematically (Rahmawati & Juandi, 2022). Implementing the STEM approach in education promotes the engagement of students in designing, developing, and utilizing manipulative tools and affective. This enables them to enhance their capacity for creative mathematical thinking while leveraging technology to further refine their cognitive skills and apply their knowledge effectively (Octaviyani et al., 2020). The syntax for the Project Based Learning model with the STEM approach proposed by Diana Laboy-Rush in (Anindayati & Wahyudi, 2020) which refers to table 3.

Table 3. 3 Syntax Project Based Learning by Diana Laboy-Rush

Phase	Syntax	Description
1.	Reflection	Connect what students know and what students need to learn.
2.	Research	Develop conceptual and relevant understanding based on projects that have been made.
3.	Discovery	Presents solutions and problem solving.
4.	Application	Testing products or solutions in solving problems.
5.	Communications	Presenting products or solutions that have been made.

The project-based learning model incorporating the STEM approach serves as an internal motivator for students to approach the study of mathematics with greater seriousness. Consequently, it indirectly enhances their interest in learning mathematics. Moreover, the project-based learning model, rooted in the STEM approach, has the potential to influence external factors such as the creation of a conducive learning environment and a fun-filled atmosphere. Additionally, fostering collaboration among students can also foster a desired learning atmosphere that encourages cooperative learning (Widana & Septiari, 2021). The PjBL model's integration with a STEM approach will be particularly advantageous because it requires students to think through a challenging problem that develops their analytical and reasoning skills. The advantages of PjBL model with STEM approach are also mentioned by Laboy-Rush in (Ulfa et al., 2019) including transferring knowledge and expertise to the real world, increasing learning motivation, and improving learning achievement. Therefore, the integration of the Project-Based Learning (PjBL) model with the STEM approach can enhance learning

activities that facilitate the attainment of learning success in terms of mastering concepts and developing students' creative thinking skills in mathematics.

3.3. The relationship between creative thinking skills and HoM in the PjBL model with the STEM approach

3.3.1. HoM in the PjBL model with the STEM Approach

Habits of mind (HoM) are mental skills and attitudes that are important in the Project Based Learning (PjBL) Model with a STEM approach. In the context of STEM PjBL, HoM helps students develop critical, creative, and collaborative mindsets. The following are some relevant HoMs in PjBL with a STEM approach, which refers to table 4.

Table 3. 4 HoM that is Relevant to PjBL with a STEM Approach

No.	Habits of mind	Activity
1.	Be firm	Students strive to deal with challenges and difficulties that arise during the project.
2.	Think flexibly	Students can find innovative solutions and can see problems from various perspectives.
3.	Dare to take responsibility and take risks	Students are responsible and contribute actively to the project being worked on.
4.	Thinking interdependently	Students build effective communication and teamwork skills.
5.	Continuous learning	Students reflect on the experiences and results of the project which help a deeper understanding.

The application of HoM in PjBL with a STEM approach encourages students to become independent, critical, and creative learners. HoM helps them develop higher-order thinking, collaboration, and problem-solving skills that are relevant in a STEM context. Through the implementation of HoM, PjBL STEM can provide in-depth learning experiences and prepare students to become future leaders in the STEM field.

*3.3.2. PjBL Model with STEM Approach to Creative thinking skills*f

Students' creative thinking skills can be developed through learning models, one of which is by using the PjBL model with a STEM approach where students will get a better understanding which will involve students actively (Mawarni & Sani, 2020). Learning using the STEM approach directly is the best way to provide training for students to be able to directly apply their knowledge in everyday life.

According to several studies, there is a significant relationship between the STEM approach's PjBL learning model and the ability for creative thought. From research data (Noviyana, 2017), the results showed that the average test of students' mathematical creative thinking skills by applying the Project Based Learning model was higher with an average student's mathematical creative thinking skills of 86.39, while students who applied conventional learning models were lower with an average students' mathematical creative thinking skills is 53.77. Based on the research that has

been done (Erisa et al., 2021), the initial and final conditions of students are different related to their creative thinking abilities. Students are more courageous and confident to convey their thoughts in their own language, not depending on the text and students find different ideas. Student learning outcomes are also increasing associated with a better understanding of learning.

The integration of the STEM approach with the PjBL Laboy-Rush model offers learning experiences that effectively cultivate students' creative thinking skills. This can be observed and summarized in Table 5.

Table 3. 5 STEM Integration with the PjBL Model for Creative Thinking Skills

PjBL syntax	STEM	Indicator of Creative thinking skills
Stage 1. Reflection Students are required to connect what they already know to what they will learn.	● Science	● Fluency ● Flexibility ● Originality
Stage 2. Research Students collect data from a variety of sources that is pertinent to or associated with the subject being researched.	● Science ● Technology	● Fluency ● Flexibility ● Originality
Stage 3. Discovery Students participate in the creation and design of products.	● Science ● Technology ● Engineering ● Math	● Fluency ● Flexibility ● Originality ● Elaboration
Stage 4. Application Students carry out product manufacture and testing for product repair if the product doesn't accordance the prior criteria.	● Science ● Technology ● Engineering ● Math	● Fluency ● Flexibility ● Originality ● Elaboration
Stage 5. Communications Students display their finished works. Moreover, having a means of receiving advice that is constructive.	● Science ● Technology ● Engineering	● Fluency ● Flexibility ● Originality ● Elaboration

PjBL-STEM learning serves as a guiding framework for students, with each step designed to accomplish a specific objective within the learning process. (Anindayati & Wahyudi, 2020). If the project-based learning model based on the STEM approach is implemented continuously in mathematics learning it can develop students' creative thinking skills (Widana & Septiari, 2021). Overall, these research demonstrate that the PjBL learning model and the capacity for creative thought are significantly positively correlated. The PjBL model gives students the chance to practise working in groups and accomplishing difficult tasks as they improve their capacity for creative thought. The STEM PjBL approach will be highly useful since it requires students to think critically about complicated issues that develop their creative problem-solving skills.

According to the findings of previous study, project-based learning with a STEM approach and the ability to think creatively are positively related. Where habits of mind affect the ability to think creatively which also when in PjBL model will help students to be more independent, critical, and creative. Likewise, with PjBL model with STEM approach which when integrated into learning consistently will train the students thinking.

4. Conclusion

It may be inferred from the literature review that was conducted that the project-based learning model combined with the STEM approach and students' habits of mind for creative thought are positively correlated. The level of habits of mind will also affect the level of ability to think creatively. Habits of mind that are often used by students in the learning process can support improving their creative thinking skills. Meanwhile, the project-based learning model facilitates students to develop their creative thinking skills through a more interactive and student-centered learning experience. Through the STEM approach, students' creativity is developed in order to be able to solve problems in everyday life and be able to reason and think critically, logically, and systematically.

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