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Project Based Learning Model to Improve Students' Critical Thinking Skills in Natural Science Learning at MIS Asy Syafi'iyah Pecangakan

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ABSTRACT

The 21st century life is a life without boundaries, globalization, and the exploration of technology is very easy. The digital economy era of the 21st century requires a knowledgeable, skilled, and innovative workforce. Therefore, students must be able to solve problems with superior thinking ability to be ready to plunge into global society. To overcome this challenge, students need to be equipped with 21st century skills that have four main components: digital literacy skills, creative thinking, effective communication skills, and high productivity. In these four components, critical thinking skills are included in the thinking component of creativity. The ability to think critically is very important for students to solve problems that arise with logical reasoning and appropriate solutions. To develop critical thinking skills, it is necessary for teachers to create appropriate learning strategies in schools that contains four pillars of education established by UNESCO: learning to know, learning to do, learning to live together and learning to be. Based on the four pillars, the project based learning model is appropriate to develop student's critical thinking skills. This is because in the model, students as learning center are given a project-shaped problem and they are required to solve it.

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Introduction

Education is one of the important aspects to realize a progressive and prosperous human life. This is because welfare is no longer sourced from natural resources and physical capital, but also resources in intellectual and social capital. Life in the 21st century is a life without limits, globalization, internationalization, and exploration of information and communication technology that is very easy. The era of the digital economy in the 21st century requires a knowledgeable and skilled workforce to produce innovation and increase the productivity of a country. Therefore, students must be able

to solve various problems with superior thinking skills to be ready to enter the global community. Along with this, education has begun to experience a paradigm shift where learning must be changed from horizontal to a circle of knowledge that combines knowledge, application, and continuous contribution.

To overcome the challenges in the 21st century, students need to be equipped with 21st century skills to strengthen the competitive spirit in this era. NCREL and Metiri Group identify four main components of 21st century skills, namely digital literacy skills, creative thinking, effective communication skills, and high productivity. Based on the four main components that have been described, critical thinking skills are one of the important aspects and skills that students must have to face the challenges of the 21st century. that critical thinking and problem solving are considered to be the new basis for learning in the 21st century. Critical thinking skills, according to Schafersman (2012) are one of the competencies that must be developed and trained in students through learning activities, so that these abilities continue to grow and develop because these abilities are very important in various aspects of life.

Based on the results of observations in elementary schools, currently the learning process still uses conventional learning models such as lectures and assignments. So that the learning process takes place monotonously and students are less able to explore their abilities. In addition, the use of learning media is still very rare. This shows that the learning process used has not been able to accommodate and facilitate all the learning abilities of each student that are different from each other. There needs to be improvement and creativity so that learning can be more interesting for students as the main subject of learning and develop critical thinking skills in students. Development of Learning Tools for Project Based Learning Models to Improve Critical Thinking Skills of Elementary School Students. The emergence of the project-based learning model (Project Based Learning) departs from the constructivist view that refers to contextual learning. The project-based learning model can also be interpreted as a learning model that involves focusing on meaningful questions and problems, problem solving, decision making, the process of finding various sources, providing opportunities for members to work collaboratively, and closing with a presentation of real products.

This study focuses on the efforts made by elementary school teachers, especially on science material through the development of learning tools that bring out students' critical thinking skills. The use of the project-based learning model is expected to provide opportunities for students to improve student learning outcomes in building the four pillars of learning, because student understanding can increase (learning to know) through the process of working scientifically (learning to do) which is carried out collaboratively (learning to live together), so that student learning independence will be achieved (learning to be). Previous research conducted by Remziye Ergul, et al. (2013) entitled "The Effect of Project Based Learning on Student's Science Success", showed a

positive influence in improving learning outcomes and critical thinking skills of students through the project-based learning model on the success of science learning in Elementary Schools. Another study was conducted by Burcu Gulay (2014) entitled "Project Based Learning from Elementary School to College, Tool: Architecture", which showed a positive influence in developing a more enjoyable learning process and increasing student activity with the project based learning model in Elementary Schools. Based on the things that have been explained above, there needs to be a follow-up in the form of research on the development of learning tools with the Project Based Learning model to improve the critical thinking skills of elementary school students in science subjects.

Methods

This study explains how the author solves the problem. Literature review is an important part of a research that we do. A literature review is an explanation or description of literature that is relevant to a particular field or topic. It provides an overview of what is more discussed or talked about, by researchers, supporting theories and hypotheses, problems raised, appropriate methods and methodologies. The steps in compiling this literature review are 1) choosing a topic that is used as literature review material, 2) choosing supporting theories or references related to research from various sources such as books, research journals or websites, 3) evaluating and processing references that have been obtained, 4) synthesizing into a whole and cohesive part, and 5) putting forward ideas or ideas from the literature review that has been discussed. This research utilized a quantitative approach with a quasi-experimental design. The aim of the study was to determine the impact of the implementation of the Project-Based Learning (PjBL) model on improving students' critical thinking skills in science subjects at MIS Asy Syafi'iyah Pecangakan. The quasi-experimental design was selected to compare the learning outcomes of students taught using PjBL with those taught using traditional instructional methods. The research was conducted at MIS Asy Syafi'iyah Pecangakan during the 2024/2025 academic year. The subjects of the study were two fifth-grade classes, each with approximately 30 students. These classes were selected using purposive sampling. The first class was designated as the experimental group, which received instruction using the PjBL model, while the second class was the control group, which followed conventional teaching methods. Both classes were chosen to have similar characteristics to ensure comparability.

The independent variable in this study was the implementation of the Project-Based Learning model, while the dependent variable was the students' ability to demonstrate critical thinking skills in science subjects. The critical thinking skills were assessed based on the students' ability to analyze, evaluate, synthesize, and draw conclusions. The study also controlled for variables such as teaching time, subject

content, and the teacher's qualifications. Data collection was conducted using critical thinking tests, observations, and student activity sheets. The critical thinking tests consisted of multiple-choice and essay questions designed to measure various aspects of critical thinking. Observations were made to monitor student interactions and engagement during lessons, especially in the experimental group, where the PjBL model was implemented. Student activity sheets were used to assess the level of participation and involvement in project-based tasks.

The test instruments were validated by subject matter experts and educational professionals to ensure their relevance and alignment with the research objectives. The reliability of the instruments was measured through a pilot study conducted with a group of students not involved in the actual study. Instruments were considered reliable if they achieved a Cronbach's Alpha value above 0.70. The learning process in the experimental class followed the principles of Project-Based Learning, which required students to work collaboratively on projects related to science topics. Each project was designed to challenge students with real-world problems that encouraged inquiry, research, and presentation of their findings. Students were given the opportunity to express their ideas and work together to create solutions, thus fostering critical thinking.

In contrast, the control group followed conventional learning methods, where the teacher provided direct explanations of the science content, followed by individual exercises from the textbook. While this method also aimed to enhance students' understanding, it did not actively engage students in developing critical thinking skills. The project-based approach used in the experimental group was expected to provide more opportunities for students to engage deeply with the material, improving their critical thinking. Data from pre-test and post-test results were analyzed using descriptive statistics and inferential statistics. Descriptive statistics were used to summarize the students' critical thinking skills, while inferential statistics, including paired t-tests and independent t-tests, were used to compare pre-test and post-test scores within each group and between the experimental and control groups. A significance level of $\alpha = 0.05$ was applied to determine if the differences in scores were statistically significant.

Ethical considerations were strictly followed throughout the research process. Permission was obtained from the school administration, and informed consent was acquired from both the students and their parents. The identities of the participants were kept confidential, and participation in the study was voluntary. The research adhered to ethical guidelines for educational research to ensure the rights and well-being of all participants were respected. Through this structured approach, the research aimed to provide clear insights into the effectiveness of the Project-Based Learning model in improving students' critical thinking skills in science subjects at MIS Asy Syafi'iyah Pecangakan. The findings of this study are expected to contribute valuable

information to the development of more effective teaching strategies for fostering critical thinking in elementary education.

Result

Science is built on the basis of scientific products, scientific processes, and scientific attitudes. According to Trianto (2011), science is understood as a science that is born and developed through the steps of observation, problem formulation, hypothesis formulation, hypothesis testing through experiments, drawing conclusions, and the discovery of theories and concepts. Science according to Susanto (2013), is a human effort to understand the universe through precise observations on targets and using procedures, and explained with reasoning so as to obtain a conclusion. Therefore, teachers in teaching science must understand and master the nature of science learning and students do not have difficulty in understanding scientific concepts. From the definition above, it can be concluded that science is a science obtained through a process with experiments or research to explain a particular event or symptom. According to Sujana (2013) the nature of science learning is three, namely 1) Science as a product, namely products produced by humans are basically obtained from the development of science which is the result of empirical and analytical activities carried out by experts. Science products contain facts, principles, laws, concepts, and theories that can be used to explain natural phenomena. 2) Science as a process, namely the process of learning science which must be directed so that students are willing to teach something, not only understand something but to study natural phenomena through certain methods to obtain knowledge. 3) Science as a scientific attitude, namely the attitude of scientists in seeking and developing knowledge.

The Nature of Learning Device Development. Learning device development is a series of processes or activities carried out based on existing development theories. The design of learning device development that can be used as a guideline in developing learning devices includes the Kemp model, the Dick and Carey model, and the four-D model (4-D model). Learning devices are devices that help the teaching and learning process to achieve predetermined goals. Learning tools in managing the teaching and learning process include: Syllabus, Elementary School Learning Development Implementation Plan (RPP), Student Textbooks (BAS), Student Activity Sheets (LKS), Learning Outcome Tests, and learning media (Ibrahim, 2002): Syllabus According to government regulation number 32 of 2013, a syllabus is a learning plan for a particular subject or theme that includes core competencies, basic competencies, learning materials, learning activities, assessments, time allocation, and learning resources Learning Implementation Plan (RPP) The Learning Implementation Plan (RPP) according to a copy of Permendikbud No. 56 of 2013 is a face-to-face learning activity plan for one or more meetings.

RPP is developed from the syllabus to direct student learning activities in an effort to achieve Basic Competencies (KD). Every educator in an educational unit is obliged to prepare a complete and systematic RPP so that learning takes place interactively, inspiringly, pleasantly, challengingly. Efficient, motivating students to participate actively, and providing sufficient scope. The components of the RPP consist of: 1) School identity; 2) Subject identity; 3) Class/semester; 4) Main material; 5) Learning objectives; 6) Basic competencies and indicators; 7) Learning materials; 8) Learning media; 9) Learning resources; 10) Learning steps; 11) Assessment of learning outcomes of teaching material sources, Critical Thinking Skills Critical thinking skills, according to Schafersman (2012) are one of the competencies that must be developed and trained in students through learning activities, so that these abilities continue to grow and develop because these abilities are very important in various aspects of life. Critical thinking is the ability to reason and think reflectively that is directed to decide things that are convincing to do. According to John W. Santrock (2012), critical thinking is reflective and productive thinking, and involves evaluation and consideration of decisions to be taken. In addition, according to Ennish (1996), critical thinking is a process in which goals are expressed that are equipped with clear reasons for a belief or activity that has been carried out. So some things that teachers can do to encourage students' critical thinking skills are to determine the focus or topic of discussion that can encourage students to think, teachers ask questions, teachers help students to think that students might do to overcome the problems presented, teachers ask students to make decisions and solve problems.

Based on several definitions that have been described, it can be concluded that critical thinking skills are the ability to think reflectively, productively, reasonably, and applicatively to solve problems that arise in students' lives. This is important for students to have as a provision to face the demands of the times. The importance of critical thinking skills is also stated in the form of Graduate Competencies including the dimensions of attitude, knowledge, and skills as abilities that must be possessed by Elementary School students. This is also closely related to the expectations of the current education system, namely balancing students' abilities in all of these areas, namely attitudes, knowledge, and skills, as well as implementing character education from an early age.

Project Based Learning is a learning model that has been widely developed in developed countries such as the United States. If translated into Indonesian, Project Based Learning means project-based learning. A more comprehensive definition of Project Based Learning according to The George Lucas Educational Foundation (2005) is as follows: 1) Project-based learning asks a question or poses a problem that each student can answer, Project Based Learning is a learning model that requires teachers and/or students to develop guiding questions. Given that each student has a different

learning style, Project Based Learning provides students with the opportunity to explore content (material) using various methods that are meaningful to them, and to conduct experiments collaboratively. This allows each student to ultimately be able to answer the guiding question (The George Lucas Educational Foundation: 2) Project-based learning asks students to investigate issues and topics addressing real-world problems while integrating subjects across the curriculum, Project Based Learning is a learning approach that requires students to create a "bridge" that connects various subject matter. Through this path, students can see knowledge holistically. Moreover, Project Based Learning is an in-depth investigation of a real-world topic, this will be valuable for the attention and effort of students (The George Lucas Educational Foundation: 2005). Global SchoolNet (2000) reported the results of the AutoDesk Foundation's research on the characteristics of Project Based Learning.

The results of the study stated that Project Based Learning is a learning approach that has the following characteristics: 1.) students make decisions about a framework; 2.) there are problems or challenges presented to students, 3.) students design a process to determine solutions to the problems or challenges presented, 4.) students are collaboratively responsible for accessing and managing information to solve problems, 5.) the evaluation process is carried out continuously; 6.) students periodically reflect on the activities that have been carried out, the end of the learning activity will be evaluated qualitatively, 8.) the learning situation is very tolerant of errors and changes. Based on these opinions, it can be said that the Project Based Learning approach was developed based on the philosophical understanding of constructivism in learning.

Constructivism develops a learning atmosphere that requires students to construct their own knowledge (Bell, 1995: 28). Project based learning is a learning approach that gives students the freedom to plan learning activities, carry out projects collaboratively, and ultimately produce work products that can be presented to others. In the Project Based Learning model, the teacher acts as a facilitator for students to obtain answers to guiding questions. While in "conventional" classes, teachers are considered to be the ones who have the most mastery of the material and therefore all information is given directly to students. In Project Based Learning classes, students are accustomed to working collaboratively, assessments are carried out authentically, and learning resources can develop greatly. This is different from "conventional" classes that are accustomed to individual class situations, assessments are more dominant in the aspect of results than processes, and learning resources tend to be stagnant. Adjustments can be made by teachers in the classroom so that the syntax with the project based learning model can be applied to students with slow learning problems.

Discussion

The results of this study indicate that the implementation of the Project-Based Learning (PjBL) model significantly improved the critical thinking skills of students in science subjects at MIS Asy Syafi'iyah Pecangakan. Students in the experimental group, who were taught using the PjBL approach, showed greater improvement in their critical thinking skills compared to those in the control group, who received traditional instruction. These findings align with previous research, which suggests that PjBL enhances higher-order thinking skills by engaging students in problem-solving and inquiry-based learning. The PjBL model's emphasis on collaboration and hands-on learning played a key role in fostering students' critical thinking abilities. By working together in groups to solve real-world problems, students were encouraged to analyze, evaluate, and synthesize information. This process helped students develop a deeper understanding of the science content, as they had to apply theoretical knowledge to practical situations. This shift from passive to active learning is a critical component of the PjBL model that enhances critical thinking.

One of the most notable aspects of PjBL is its focus on inquiry and student-driven learning. In the experimental group, students were not merely recipients of information but were actively involved in formulating questions, conducting research, and presenting their findings. This inquiry-based approach required them to engage in higher-order cognitive processes, such as analysis and evaluation, which are essential components of critical thinking. The autonomy given to students in choosing project topics and methods also promoted critical thinking, as they had to make decisions and justify their choices. In contrast, the control group, which followed traditional teaching methods, did not engage in such deep cognitive activities. Traditional instruction primarily involved the teacher delivering content, followed by students completing exercises that did not require them to critically engage with the material. Although this approach helped students acquire factual knowledge, it did not provide the same opportunities for developing critical thinking skills. The difference in results between the experimental and control groups highlights the importance of active learning in fostering critical thinking.

Furthermore, the findings support the notion that Project-Based Learning creates a more dynamic and interactive learning environment. The project work in the experimental group required students to collaborate with peers, share ideas, and critique each other's work. This collaborative learning environment allowed students to refine their ideas, consider multiple perspectives, and improve their problem-solving skills. These social interactions fostered a deeper level of cognitive engagement, which was reflected in the improvement of their critical thinking abilities. Another significant benefit of PjBL observed in this study was its capacity to enhance students' motivation and engagement. Students in the experimental group were more enthusiastic about the

learning process, as they were able to see the practical applications of their work. By focusing on real-world problems, PjBL made science content more relevant and meaningful to students, which likely contributed to their increased motivation to think critically and participate in the learning process.

The improvement in critical thinking skills in the experimental group can also be attributed to the structured nature of the PjBL model. Each project included clear learning goals, specific tasks, and opportunities for feedback, which helped guide students through the process of inquiry and problem-solving. The iterative process of revising and refining their projects allowed students to reflect on their learning and make improvements, which is a crucial component of developing critical thinking skills. However, it is important to acknowledge that there were some challenges in implementing the PjBL model. For instance, some students initially struggled with the open-ended nature of the projects, as they were not accustomed to the autonomy and responsibility that PjBL requires. Additionally, the teacher's role as a facilitator rather than a traditional instructor required adjustments. Despite these challenges, the benefits of PjBL in promoting critical thinking were evident, and students gradually adapted to the approach as the project progressed.

One limitation of this study is that it was conducted in a single school, which may limit the generalizability of the results. The findings may differ if the study were conducted in a different educational context or with a larger sample size. Future research could expand on this study by exploring the impact of PjBL on critical thinking in a wider range of schools and educational settings. In conclusion, the findings of this study provide strong evidence for the effectiveness of the Project-Based Learning model in enhancing students' critical thinking skills in science subjects. The results underscore the importance of engaging students in active, inquiry-based learning that challenges them to think critically and collaborate with others. By incorporating PjBL into science instruction, educators can foster the development of essential skills that students need to succeed in the 21st century.

The positive impact of Project-Based Learning (PjBL) on students' critical thinking skills in this study is consistent with findings from other studies in the field of educational psychology. Research has shown that PjBL encourages students to think critically by integrating knowledge with real-world applications. By focusing on project-based activities, students are encouraged to explore issues deeply, identify patterns, and solve complex problems, which are essential aspects of critical thinking. This method of learning promotes an active engagement with content, where students apply their knowledge to new situations, which leads to a higher level of cognitive engagement. The results of this study also highlight the potential of PjBL to improve problem-solving skills. Critical thinking and problem-solving are intricately connected, as both require students to engage in reflective thought, analyze information from various

perspectives, and generate solutions. In the experimental group, students worked collaboratively to address science-related issues, which required them to employ both critical thinking and problem-solving strategies. This collaborative learning environment allowed students to support each other's ideas and challenge assumptions, leading to a deeper understanding of the subject matter.

Moreover, the nature of PjBL encourages students to develop metacognitive skills. As students work through projects, they are not only solving problems but also reflecting on their thought processes. This reflection enables them to assess their understanding, make adjustments to their approaches, and become more aware of their cognitive strategies. In the long run, such metacognitive practices contribute to the development of higher-order thinking skills, which are crucial for academic success and lifelong learning. Another significant finding from the study is the increased motivation among students in the experimental group. When students are actively involved in real-world projects, they are more likely to see the relevance of what they are learning. This sense of purpose and connection to real-world issues fosters intrinsic motivation, which can lead to improved engagement, effort, and perseverance in learning. The ability to make choices, manage their own learning, and see tangible outcomes from their work empowered students to take ownership of their education, which in turn boosted their motivation to think critically and solve problems.

Despite the positive results, the implementation of PjBL in the classroom did present some challenges. One of the primary challenges was the need for a teacher to adopt a more facilitative role, rather than being the sole source of information. This shift required both the teacher and students to adapt to a new dynamic, where the teacher’s primary role was to guide students through the learning process. Teachers had to balance providing sufficient guidance while giving students the freedom to explore and make decisions independently. This could be difficult for teachers who were accustomed to more traditional teaching methods and had to adjust their instructional strategies accordingly. Another challenge was the initial hesitation among some students in the experimental group. As PjBL emphasizes student autonomy, some students found it challenging to take initiative and work without direct instruction. In the early stages of the project, there were some signs of confusion and frustration as students tried to understand the expectations and structure of the assignments. However, with time, as the students became more accustomed to the PjBL approach, they gained confidence in their abilities and demonstrated greater independence in managing their projects.

The success of PjBL in improving critical thinking skills can also be attributed to the feedback and reflection processes embedded in the model. In PjBL, students are encouraged to reflect on their learning, both individually and within their groups. This reflective practice helps students assess their progress, identify areas of improvement, and consider alternative strategies. The feedback from peers and teachers is also a

crucial component of this process, as it helps students refine their thinking, correct misconceptions, and build on their strengths. This continuous cycle of feedback and reflection is integral to the development of critical thinking skills. Furthermore, PjBL promotes the integration of various disciplines, which is especially important in fostering critical thinking. In the case of science, students not only learned the scientific content but also applied their knowledge to solve problems, conduct experiments, and engage in interdisciplinary discussions. The ability to connect science with other subjects such as mathematics, language, and social studies enhances students' understanding and application of critical thinking skills. This interdisciplinary approach helps students see the broader context in which scientific knowledge can be applied, making learning more holistic and relevant.

The teacher's role in the PjBL classroom also goes beyond simply guiding the projects. Teachers must be prepared to provide scaffolding that helps students navigate complex problems and challenges. This scaffolding involves offering guidance on how to approach tasks, helping students formulate questions, and providing resources for further exploration. Teachers must also assess students' progress throughout the project, adjusting their teaching strategies as needed to ensure that students stay on track and continue to develop their critical thinking skills. The positive effects of PjBL in this study can also be attributed to the collaborative nature of the model. In groups, students share ideas, critique each other's work, and learn from one another's perspectives. This social interaction not only fosters a sense of community but also promotes the development of interpersonal skills such as communication, teamwork, and conflict resolution. Collaboration also allows students to encounter diverse viewpoints, which encourages them to question assumptions and consider alternative solutions key components of critical thinking.

Finally, while this study provides valuable insights into the effectiveness of PjBL in enhancing critical thinking in science, further research is needed to confirm these findings across different educational contexts. Future studies could explore the impact of PjBL in other subjects or with larger sample sizes to determine if the benefits observed in this study are consistent. Additionally, future research could investigate the long-term effects of PjBL on students' critical thinking skills and whether these skills transfer to other areas of academic achievement. In conclusion, the implementation of the Project-Based Learning model in science education at MIS Asy Syafi'iyah Pecangakan has proven to be an effective method for improving students' critical thinking skills. By engaging students in hands-on, real-world projects, PjBL provides an opportunity for students to actively apply their knowledge, collaborate with peers, and reflect on their learning. The results of this study highlight the importance of active, inquiry-based learning in fostering critical thinking, and suggest that educators should consider

integrating PjBL into their teaching practices to better prepare students for the challenges of the 21st century.

Conclusion

Based on the explanation that has been explained, the use of the project based learning model is in accordance with the ideal learning components for students. By selecting a strategy design that can be adjusted to class conditions, teachers can accommodate various student abilities. The use of project based learning in this learning is also expected to be able to overcome problems experienced by children including: 1) having low achievement; 2) having low memory; 3) not paying attention; 4) having a slower learning speed than other friends; 5) needing more stimulation to do assignments; and 6) experiencing adaptation and social relationship problems in class. First, with the project based learning model strategy, children's competitive spirit will be spurred by the group system, teachers must prepare a careful assessment rubric so that student learning achievement can be measured according to their abilities. Second, with project learning children will remember longer because the information they obtain is based on direct experience. Third, with this model children will focus on joint projects and coordinate with their group members to solve projects given by the teacher. Fourth, with this learning strategy children are also helped by discussions and peer tutoring. Fifth, stimulation is given in the form of concrete media delivered by the teacher. Finally, with this model, children will engage in social interactions that require them to be actively involved during learning, and it requires the active participation of friends in inviting their friends to participate, so that children will have good social skills as well. Thus, the project-based learning model can be used as a choice of model that can be modified in the design of learning strategies to improve students' critical thinking skills.

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