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Fostering Scientific Literacy Through Problem-Based Learning: A Path to Enhanced Student Skills

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ABSTRACT:
This study examines the effectiveness of problem-based learning (PBL) as a pedagogical approach to enhance scientific literacy among students. By engaging learners in real-world problems and collaborative inquiry, PBL fosters critical thinking, problem-solving skills, and a deeper understanding of scientific concepts. The research highlights various strategies for implementing PBL in educational settings, demonstrating its positive impact on student engagement and motivation. Through a series of case studies and assessments, we showcase how PBL not only improves students' scientific knowledge but also prepares them to navigate complex scientific challenges in their future careers. Ultimately, this study advocates for the integration of problem-based learning as a vital component of science education to cultivate a scientifically literate society.
Keywords: scientific literacy, problem based learning, Engineering Physics.

1. INTRODUCTION

In today’s rapidly evolving world, scientific literacy has become essential for informed decision-making and active participation in society. As scientific advancements increasingly impact various aspects of daily life, individuals must possess the ability to understand, analyze, and evaluate scientific information. However, traditional educational approaches often fall short in fostering the critical thinking and problem-solving skills necessary for students to navigate complex scientific concepts and real-world challenges. This underscores the urgent need for innovative pedagogical strategies that can effectively cultivate scientific literacy.

Problem-based learning (PBL) emerges as a promising educational framework that actively engages students in the learning process through real-world problems. PBL shifts the focus from rote memorization of facts to collaborative inquiry, encouraging students to explore, investigate, and devise solutions to authentic issues. This approach not only enhances understanding of scientific concepts but also promotes the development of essential skills such as critical thinking, creativity, and teamwork. By immersing students in meaningful problem-solving experiences, PBL empowers them to take ownership of their learning, making science relevant and applicable to their lives.

Numerous studies have highlighted the benefits of PBL in promoting deeper learning and engagement. Research indicates that students engaged in problem-based learning exhibit greater motivation, improved retention of knowledge, and enhanced ability to apply scientific concepts in novel situations. Furthermore, PBL prepares students for the complexities of the modern world by equipping them with the skills necessary to approach scientific inquiries and challenges critically.

This study aims to explore the effectiveness of problem-based learning as a means of cultivating scientific literacy among students. Through a comprehensive analysis of PBL strategies and their implementation in educational settings, we will examine the impact of this approach on student engagement, skill development, and overall scientific understanding. By showcasing various case studies and assessment results, we hope to demonstrate the transformative potential of problem-based learning in science education.

In the following sections, we will delve into the theoretical underpinnings of PBL, its practical applications in the classroom, and the outcomes of its implementation. Ultimately, this exploration seeks to advocate for the widespread adoption of problem-based learning as a vital component of science education, fostering a generation of scientifically literate individuals equipped to address the challenges of the future.

2. METHOD

The method used to collect data on improving students' scientific literacy abilities in research is the classroom action research method. The implementation of this classroom action research was carried out in 2 cycles. Each cycle has 4 activities, namely planning, acting, observing, and reflecting (Juanda, 2016). Cycle 1 was carried out in 2 meetings. Observation and reflection activities in cycle 1 became the basis for determining the implementation of cycle 2 with a minimum percentage of students' scientific literacy ability of 70% for each indicator. The sample in this study were 28 students in the first semester of the Computer Science Study Program, Faculty of Engineering, Graha Nusantara University Padangsidimpuan.

The data collection technique used in this study is a test technique. The instruments used were student worksheets (LKM) and scientific literacy ability test sheets according to scientific literacy ability indicators. The scientific literacy ability indicators used refer to aspects of the PISA scientific literacy assessment (OECD, 2017), namely context, knowledge, competencies, and attitudes.

3. RESULTS AND DISCUSSION

Improving students' scientific literacy abilities in this study was carried out by applying problem based learning to the teaching of Engineering Physics. This research was conducted in 2 cycles. The first cycle was applied to the quantity and measurement material, while the second cycle material was Kinematics. The percentage of students' scientific literacy abilities in cycle I can be seen in the following table

Table 1. Scientific Literacy Ability of Students in Cycle I

Indicator	Percentage
Context	67,86%
Knowledge	60,71%
Competencies	53,57%
Attitudes	42,86%

The results of observations in cycle I showed that students' scientific literacy skills had not reached the targeted percentage of 70%. Therefore, reflection and improvement was carried out in the second cycle. The percentage of students' scientific literacy abilities in cycle II can be seen in the following table

Table 2. Scientific Literacy Ability of Students in Cycle II

Indicator	Percentage
Context	82,14%
Knowledge	85,71%
Competencies	78,57%
Attitudes	75,00%

The results of observations in cycle I and cycle II show that students' scientific literacy skills have increased by applying problem based learning (PBL). The increase in scientific literacy can be seen in the following graph.

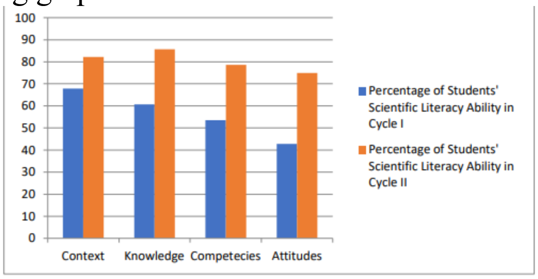

Figure 1. Increasing Students' Science Literacy Ability in Cycles I and II

The aftereffects of perceptions in this homeroom activity research showed that there was an expansion in understudies' logical education abilities utilizing the issue based acquiring (PBL) model. The capacity of understudies' logical proficiency in every marker in cycle II expanded from cycle I.

The setting of logical education incorporates areas of science application which incorporate individual, neighborhood and worldwide issues. In cycle I it very well may be seen that understudies' logical proficiency capacities on setting markers are as yet missing, to be specific with a level of 67.86% of the all out number of understudies who responded to questions accurately connected with the setting of logical education, implying that's first experience with the encompassing life circumstance connected with amount and estimation is as yet deficient. In cycle II, the setting marker expanded to 82.14%. This shows that the presentation of understudies about the encompassing regular peculiarities connected with kinematics is improving.

Logical education information portrays' comprehension understudies might interpret realities, hypotheses and ideas that form the groundwork of logical information. The mark of logical proficiency information in cycle I was still somewhat low, to be specific with a level of 60.71% of understudies who addressed accurately. This present circumstance demonstrates that understudies are as yet unfit to relate peculiarities that happen in their environmental factors with the fundamental information they have obtained. In cycle II the logical education information marker expanded to 85.71% who addressed accurately. This shows that understudies are progressively ready to break down occasions in the normal environmental elements and how these occasions can happen with the logical ideas and hypotheses they have.

Logical education capability pointers allude to understudies' capacity to distinguish and make sense of logical peculiarities in light of logical information, and utilize existing proof to reach determinations. In cycle II 53.57% of understudies addressed accurately on the skill pointer, implying that understudies' logical capacities were still exceptionally low in exploring and assessing peculiarities that happened in the normal environmental factors. Capability markers in cycle II expanded with a level of 78.57%. This figure shows that understudies' capacities are getting better at making sense of encompassing regular peculiarities, planning and leading examinations, reaching inferences, and deciding suitable arrangements.

Mentality markers in cycle I are displayed with an extremely low level of 42.86%. After the execution of this first cycle, it just so happens, the mentality of understudies towards peculiarities that happen in the universe is still extremely deficient. In cycle II this marker expanded radically with a level of 75%. After the execution of cycle II, understudies' anxiety for the regular environmental factors expanded, interest in science and innovation likewise expanded. Interest in logical peculiarities urges understudies to attempt to tackle issues connected with science (NisaWulandari, 2015).

Logical education capacity as per PISA (OECD, 2017) is the capacity to utilize logical information, recognize questions and depict realities to have the option to comprehend and make ends
about the universe and changes to nature because of human exercises. The capacity of the logical education setting can be accomplished through the most vital phase in carrying out issue based learning, specifically guiding understudies to issues. Understudies start to ponder applications or peculiarities connected with science that exist both in the school climate and around their homes. The second move toward PBL, to be specific getting sorted out understudies to learn is connected with marks of information in logical proficiency. In this stage understudies start to gather different data about the issues they experience in the climate and comprehend them with the essential information they have.

The subsequent stages in issue based learning are leading examinations, creating and introducing the work, as well as dissecting and assessing the critical thinking process. These three stages are connected with logical education ability markers. In view of the peculiarities that happen and the information moved by understudies, they can form explicit issues, examine all the data gathered, develop causal connections, and track down different potential answers for take care of issues. Then among the few arrangements understudies can accept the best arrangement as an end. Marks of logical education perspectives can be found from each step of issue based discovering that understudies go through. Demeanor pointers remember understudies' revenue for science and innovation, appraisal of logical ways to deal with examinations, and insights and attention to the general climate (Betari, 2016). The disposition of logical education raises understudies' aversion to their current circumstance so they attempt to find answers for peculiarities that happen to accomplish balance throughout everyday life.

The aftereffects of this study show that there wsan expansion in understudies' logical proficiency abilities through issue based acquiring. This is as per the discoveries (Betari, 2016; Mundzir, 2017). The general low capacity of logical education in cycle I was brought about by understudies not being know about the use of issue based learning models. Understudies' reasoning is as yet centeredaround the speculations they learn, while the utilization of science, understudies' advantage logical skill actually should be gotten to the next level. In cycle II, the level of logical education pointers expanded after enhancements were produced using cycle I and understudies had started to be prepared in applied learning.

The learning process using the problem-based learning model makes students more enthusiastic in participating in the learning process, students are more active, interested and concentrated so that scientific literacy skills can increase. This is consistent with the advantages of using problem-based learning models (Kurniasih, 2016), including: increasing students' creativity and critical thinking; motivating students to learn; help transfer students' knowledge in new situations; motivating students to be creative and innovative in proving problem investigations; foster a desire to work together and can develop good relationships in group work.

4. CONCLUSION

This study highlights the significant role of problem-based learning (PBL) in cultivating scientific literacy among students. By actively engaging learners in real-world problems and collaborative inquiry, PBL fosters critical thinking, problem-solving abilities, and a deeper understanding of scientific concepts. The findings underscore that traditional teaching methods often inadequately prepare students for the complexities of modern scientific challenges. In contrast, PBL provides a dynamic and interactive learning environment that not only enhances student motivation but also encourages them to take ownership of their educational journey.

The implementation of PBL strategies within the classroom has shown promising results, as evidenced by various case studies and assessments. Students engaged in PBL exhibited improved retention of knowledge, increased ability to apply scientific principles in new contexts, and a heightened sense of relevance regarding their studies. Furthermore, PBL promotes essential skills such as collaboration, communication, and creativity, which are vital for success in both academic and professional settings.

As we move forward in an increasingly scientific and technological world, fostering scientific literacy becomes imperative. Educators must prioritize the integration of innovative teaching approaches like problem-based learning to prepare students for the complexities they will encounter. This study advocates for broader adoption of PBL in science education, recognizing its potential to develop a generation of learners who are not only knowledgeable but also capable of critical thought and informed decision-making.

In conclusion, the cultivation of scientific literacy through problem-based learning is not merely an educational enhancement; it is a necessity for empowering students to become informed citizens who can engage with the scientific issues that shape our world. By embracing PBL as a fundamental pedagogical approach, we can pave the way for a more scientifically literate society, equipped to face the challenges of the future.

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