



Problem-Based Learning Integration in Stem Education to Improve Environmental Literation

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Abstract

This study aims to see the integration of problem-based learning in STEM education can improve the environmental literacy of elementary education students. The research is qualitative and uses the literature study method. Searching journals from the Science Direct search engine, Science Education Journal, ERIC, Google search engine, and others with the keywords Problem-Based Learning, Science, Technology, Engineering and Mathematics (STEM), environmental literacy, scientific literacy resulted in 3,298 journals. Derived from Scencedirect 2016 journals, ERIC 873 journals, Indonesian Science Education Journal 49 journals. Through the above process, 8 journals were obtained. The appropriate journal was then analyzed and extracted. Journals that mostly show the STEM integrated Problem Based Learning learning method as one of the learning methods which is expected to be able to increase the literacy of students. This achievement is determining environmental problems, initiating ideas, mastering environmental problems, controlling environmental problems, creating products as a form of overcoming environmental problems and testing these products. This is because environment-based learning is effective in improving the attitudes and knowledge of students. Based on the results of the literature review, it can show that the application of STEM education that is integrated with the PBL learning model can improve environmental literacy in basic education students.

Keywords: *Problem Based Learning; STEM Education; Environmental Literacy*

Introduction

From time to time, environmental problems are increasingly difficult and complex, while the human ability to overcome environmental problems does not increase significantly compared to the increase and complexity of environmental problems themselves (Purwanto, 2012; Setiawan et al., 2020). This problem is mostly caused by people's behavior that badly threatens the environment. This is closely related to community education and the way humans get environmental literacy in schools (Fenny et al., 2019; Yetti et al., 2021).

Schools are required to be able to change the mindset of the community regarding the level of education and environmental preservation and this is a very difficult task. Many people do not have a background in environmental education (Iasha, 2018; Juniarmo et al., 2020). Environmental literacy is needed to create an environmentally sound society that is aware of the meaning of ecology and the environment for the sustainability of human life (McBride et al., 2013). The fact that environmental topics are taught but students' environmental literacy is quite low. It is assumed that most learners only focus on cognitive skills. Students mostly learn about ecology but rarely observe the ecological problems around them (Rachamatika et al., 2021; Sudrajat et al., 2021). Therefore, the learning process must be adapted to an innovative learning process that improves the cognitive skills of students as well as their attitudes and behavior (Asrifah et al., 2020; Farida et al., 2017).

Based on the results of the Program for International Students Assessment (PISA) study on scientific literacy which is carried out every three years, it was revealed that the scientific literacy of Indonesian students in competing at the international level still needs to be improved, it is proven that in 2015 the scientific literacy of Indonesian students was ranked 64th from 75 countries (Iasha et al., 2020; Kristiyowati & Purwanto, 2019).

Kristiyowati and Purwanto state that "many factors can affect the low environmental literacy of students (Kristiyowati & Purwanto, 2019). One of the factors that cause low environmental literacy skills is the selection of learning sources". In Indonesia, environmental literacy is still limited to textbook material or text instead of direct learning. The learning method is still teacher-centered with the lecture method, not an interactive, innovative, and creative method (Acesta et al., 2021; Marudut et al., 2020).

In this study, the strategy used was the application of the Problem Based Learning (PBL) model. Problem Based Learning is an innovation in problem-based learning models because, in PBL, students' thinking skills are optimized through a systematic group or teamwork process so that students can empower, hone, test, and develop their thinking skills continuously (Pramujiono et al., 2020; Setiawan et al., 2021). PBL is a student-centered learning process that empowers students with research simulations, integrates theory and practice, and develops skills and knowledge related to problem solutions (Brown et al., 2013). PBL can help students to develop thinking skills and problem-solving skills (Majir, 2019; Nurjanah et al., 2021).

The integration of a model approach in learning has been carried out by several developed countries, namely by developing Science, Technology, Engineering, and Mathematics (STEM) education. STEM education can support critical thinking skills that will make students solve problems creatively so that it is useful for the world of work (White, 2014). Several studies have shown that STEM learning can be achieved through Problem-Based Learning (PBL) (Afriana et al., 2016; Farwati et al., 2017a; Lee et al., 2019; Navy & Kaya, 2020). STEM learning fits perfectly with the characteristics of PBL learning. PBL learning aims to help students understand deeper concepts, build confidence to face problems, build collaboration in teams, train students to take a systematic approach to solve problems, make decisions and present them, and conduct competitions to get better results (Capraro et al., 2013; Suryanto et al., 2017).

Based on existing research, it shows the development of integrated PBL approach research in STEM education which is strongly suspected of being able to develop students' environmental literacy, so it is necessary to conduct a literature study to be able to dig deeper about PBL-STEM integration in actualizing environmental literacy to get a better understanding. The results of previous research indicate that STEM integrated with PBL still faces obstacles, such as: having limited experience with content, reducing the effect of individual content areas, and requiring better curriculum alignment (Navy & Kaya, 2020). Other research directs the integration of PBL-STEM to only part of subject areas, such as mathematics (Lee et al., 2019). There is research on PBL-STEM integration in primary schools which is associated with scientific literacy (Afriana et al., 2016). The research studied n environmental literacy such as Farwati et al. (2017a) but focus on non-primary school students.

Methodology

This research is a literature study or library research with a qualitative approach. Literature study is research that is carried out by collecting data or several scientific papers that are library in nature with certain relevant research objects from previous research as a data source. The research objective of this literature study is to obtain a theoretical basis that can support solving the problem being studied and reveal various theories that are relevant to the case, more specifically in this study, wants to examine the integration of Problem-Based Learning in STEM education which can improve students' environmental literacy.

The data used in this research came from books, dissertations, theses, theses, and journals that were updated in the last 10 years (2010-2020) both national and international libraries. In conducting this research, the researchers searched library data published on the internet using search engines using the keywords Problem-Based Learning, STEM, Science Literacy, Environmental Literacy, Environmental Literacy for international and national journals. Parameters that become keywords are ((Problem-Based Learning [Title / Abstract]) AND STEM [Title / Abstract]) or ((environmental literacy [Title / Abstract]) AND integrated PBL-STEM [Title / Abstract]))

The data analysis techniques after the sample and data were collected are as follows: (1) data reduction, namely removing unnecessary things and focusing on important things; (2) data exposure, namely describing the data presented based on certain subsections; and (3) concluding new findings that had never existed before.

Results and Discussion

This study discusses several journals related to the PBL-STEM learning model and scientific literacy. The results of several journals that have been compiled are listed in Table 1 and their descriptions.

Tabel 1 Collection of articles / journals for analysis

No	Research Title	Year
1.	Project-Based Learning Integrated STEM to Enhance Elementary School's Students Scientific Literacy	2016
2.	Enhance Environmental Literacy through Problem Based Learning	2017
3.	Pengaruh PjBL Terintegrasi STEM Terhadap Literasi Sains, Kreativitas, Dan Hasil Belajar Peserta Didik	2018
4.	The Effect Problem Based Learning for Student's Environmental Literacy	2018
5.	Pengaruh Gabungan STEM Yang Diintegrasikan Dengan Pendekatan PBL Untuk Meningkatkan Kemampuan Literasi Lingkungan Mahasiswa Program Studi Pendidikan Biologi	2020
6.	Integrated STEM Through Project-Based Learning and Guided Inquiry on Scientific Literacy Abilities in Terms of Self Efficacy Levels	2020
7.	<i>PBL as a Pedagogical Approach for Integrated STEM: Evidence from Prospective Teachers</i>	2020
8.	Dampak pembelajaran berbasis masalah pada pengetahuan konten dan pemikiran kritis peserta didik terhadap STEM	2020

Based on Table 1, several journals were then reviewed for content analysis. The results of the analysis are as follows.

Afriana et al. (2016) describe Project Based Learning (PjBL) which is integrated with STEM, to increase the scientific literacy of basic education students. The theme used is air pollution. The research method is quasi-experimental with The Matching-Only Pretest-Posttest Control Group Design. The study was conducted on 56 students of class VII SMP Islam Terpadu Sukabumi consisting of 28 students in the experimental class and 28 students in the control class. Data collection was carried out by pretest and posttest scientific literacy and student questionnaires about PBL-STEM. Based on data analysis, it is known that the average N-Gain of the science literacy class is 0.31 in the moderate category of the experimental class and 0.22 in the low category control class. The t-test shows that the increase in scientific literacy in the experimental class is more significant than in the control class. Students' responses, in general, indicate that almost all students are enthusiastic about PBL-STEM learning, get impressive experiences during learning and increase their motivation and interest in learning.

Febriasari & Supriatna (2017) in their research aims to improve environmental literacy in elementary school students in the city of Bandung. This research design uses classroom action research which consists of four stages, namely planning, implementing, observing, and reflecting. The results showed that there was an increase in students' environmental literacy. This study concludes that students' environmental literacy can be improved through classroom learning by applying the Problem Based Learning (PBL) model. It is important to do lesson planning which includes analysis of environmental literacy components and learning models used by PBL so that learning can run effectively, efficiently, and get maximum results. Efforts to increase environmental literacy must be sustainable.

Lutfi et al. (2018) examined the effect of implementing the PBL STEM model on improving scientific literacy, creativity, and student learning outcomes. This study was a quasi-experimental study with a non-equivalent pre-test post-test control group design. The population of this study was students of class X SMAN 11 Sinjai. The sample chosen was the MIA 2 class as the experimental class and the MIA 1 class as the control class selected using the purposive sampling technique. The results showed that the value of the experimental class > the value of the control class. After the paired t-test was carried out, it was found that the significance was $0.000 \leq \alpha = 0.05$, then the conclusion was that there was an effect of the application of the integrated PBL STEM learning model on increasing scientific literacy, creativity, and learning outcomes of students. This model is effectively applied to pollution based on learning outcomes and has received a very positive response from students.

Roshayanti et al. (2019) in their research aimed to determine the effect of problem-based learning (PBL) in improving students' environmental literacy. This study used a quasi-experimental design. Involving 50 grade 1 student of SMA Negeri 10 Semarang. Experimental class students were taught with a problem-based learning model while the control class was taught with a conventional model. The data collected in this study were students' environmental literacy collected through a secondary school environmental literacy survey (MSELS). The first validity of the MSELS instrument with rash analysis. The collected data were then analyzed using covariate analysis (ANCOVA). The results showed that there were differences between the PBL class and the conventional class in improving students' environmental literacy skills with a significant value of 0.002. These results indicate that the PBL model can strengthen students' environmental literacy well.

Anita et al. (2020) in their research aimed to determine the effect of the combined STEM integrated with the PBL approach to improving environmental literacy skills of students of the Puangrimaggalutung University biology education study program, Sengkang. This study used a Quasi-Experimental Design research design using the Nonequivalent Control Group Design research design. This research was conducted in the Biology Education Study Program of Puangrimaggalutung University. The instrument used in this study was the 2018 MSELS (Middle School Environmental Literacy Survey) which has been adopted at several points to adapt to environmental conditions in Indonesia as well as questions related to environmental change material. The results showed that the problem-based learning model affected improving the environmental literacy skills of the students in Biology Education at Puangrimaggalutung University.

Lestari & Rahmawati (2020) in their research found the difference in the effect of learning with project-based models and STEM integrated guided inquiry models on students' scientific literacy skills in terms of the level of self-efficacy. This research was conducted at the Cibatok 1 State Elementary School, with the subject of the research being 52-grade students. This study used a quasi-experimental method with a 3X2 factorial design. Two classes were given treatment, class V-A was given a project-based model treatment, while class V-C was given a guided inquiry model treatment. The instrument used consisted of a questionnaire on the level of self-efficacy and a test of scientific literacy skills, the instrument had been tested for validity and reliability. Data analysis was performed using the two-way Anova test. Based on the research results, it was found that: (1) there was no difference in the effect of problem-based learning and guided inquiry learning models on scientific literacy skills; (2) there are differences in scientific literacy abilities between students with high, medium and low levels of self-efficacy; (3) the science literacy abilities of students with high self-efficacy levels are better than moderate and low self-efficacy levels; (4) there is an influence of the interaction of the learning model with the level of self-efficacy together on the scientific literacy abilities of students. The findings of this study are expected to be used practically for teachers to develop aspects of self-efficacy and scientific literacy skills of students.

Navy & Kaya (2020) in their research investigated how 47 elementary teacher candidates developed PBL units and how to integrate STEM and other disciplines into these units. It also addresses the issue of affordability and constraints of integrated STEM as perceived by prospective primary school teachers. Sources of data in this multimethod study include PBL units and interviews. The findings reveal that all units integrate at least two STEM disciplines, as well as literacy, in multiple ways. Teacher candidates articulate the perceived benefits of integrated STEM, such as: making connections across content areas, preparing students for the real world, teaching students that failure is not a bad thing, and providing opportunities for the future. Perceived barriers to integrated STEM, such as: having limited experience with content, reducing the effect of individual content areas, and requiring better curriculum alignment. Overall, this study provides evidence that PBL can be a pedagogical approach to integrating STEM. Implications for teachers, teacher educators, and curriculum specialists.

Rehmat & Hartley (2020) investigated the impact of problem-based learning on the content knowledge and critical thinking of students in STEM. This study used a quasi-experimental repeated measurement design. Instruments such as STEM content assessments and standardized critical thinking tests were used for data collection. Analyses were performed using repeated measures of mixed between-subject analysis of variance (ANOVA). The results revealed a significant difference ($p < .05$) between problem-based learning and traditional group learning in terms of content knowledge and critical thinking skills.

Conclusion

Based on the results of the literature review, it can be concluded that the application of STEM education that is integrated with the PBL learning model can improve environmental literacy in basic education students. In basic education, the implementation of the STEM-based PBL model can identify increased knowledge attainment, character development, and skills enhancement. This achievement is determining environmental problems, initiating ideas, solving environmental problems, designing environmental problem solutions, creating products as a form of overcoming environmental problems, and testing and evaluating these products. This is because environment-based learning is effective in improving the attitudes and knowledge of students. The application of PBL in schools can provide a conducive learning environment for students and ultimately trigger students' actions in saving the environment. The successful application of PBL-STEM is determined by the learning experience in the classroom and other learning environments. This activity is not only to increase environmental knowledge and literacy but also to train sensitivity which in turn will trigger student action in saving the environment.

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