

Fostering Environmental Literacy through Innovative Learning: Using PBL-based Science E-books Integrated with Local Potential of Rawa Bento

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ABSTRACT (10 PT)

Students' poor environmental literacy is a problem that has to be fixed. This research is important because low environmental literacy among students can negatively impact their ability to understand and address environmental issues in the future. This study looked at how students' environmental literacy levels changed after using the PBL-based Rawa Bento integrated science e-book in learning. This study aims to evaluate the effect of using PBL-based Rawa Bento integrated science e-books on students' environmental literacy. This study involved grade VII students at SMPN 6 Yogyakarta with a quasi-experimental design. There are two research groups: the modeling group and the implementation group. Both groups received science learning using the PBL-based Rawa Bento integrated science e-book. Multiple-choice exams were used to collect data on environmental literacy, which SPSS 21 was then used to analyze. The results showed that in the modeling group, before and after learning, there was no discernible difference in environmental literacy. However, in the implementation group, there were significant differences and the size of the effect was moderate.



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INTRODUCTION

In the Merdeka Junior High School Curriculum phase D, Natural Science (Science) subjects are focused on material content and process skills. Learning Outcomes (CP) for Science Subjects at the Junior High School / MTs Phase D Level are listed in the Decree of the Head of BSKAP Number 033 / H / KR / 2022 concerning Changes to the Decree of the Head of the Education Standard, Curriculum and Assessment Agency. The Merdeka Curriculum is a new national curriculum, which is based on reflections on the implementation of the 2013 Curriculum. One of the fundamental changes in the Independent Curriculum, especially in

science subjects at the SMP/MTs/equivalent level, is: (1) focus on material content and process skills in science subjects, (2) emphasis on differentiated learning in the teaching-learning process, and (3) Core Competencies/Basic Competencies turn into Learning Outcomes that integrate attitudes, knowledge, and skills (Kemendikbudristek, 2022).

Science subjects are very relevant to introduce environmental concepts, because science includes knowledge about nature and its environment. Environmental education in science subjects will help students understand environmental concepts and how humans can interact with the environment positively (Santika et al., 2022). The Merdeka Curriculum gives teachers flexibility to design high-quality instruction that meets students' needs and their learning environment (Angga & Iskandar, 2022). The integration of environmental literacy in science subjects in the Merdeka Curriculum can help students understand the importance of maintaining environmental sustainability and how humans can interact with the environment positively. Additionally, it can assist students in developing the abilities needed to meet the problems of the twenty-first century and make a future contribution to the sustainability of the environment.

However, several assessments have shown a low level of environmental literacy among students in Indonesia, particularly in the cognitive aspect. Their environmental literacy levels are still relatively low (Nasution, 2016; Santoso et al., 2021). This is also reflected in the results of the Program for International Student Assessment (PISA), where Indonesian students' performance in environmental science and geoscience ranked 51 out of 57 participating countries (OECD, 2009). Therefore, efforts are needed to help improve students' environmental literacy.

In addition to the issue of environmental literacy, there are also problems with the implementation of teaching models and the use of teaching materials in middle school science education. Based on observations in 7th-grade science classes at SMPN 6 Yogyakarta, it was found that the use of discussion, lectures, and practical work with textbook materials and PowerPoint media was the preferred choice for teachers. However, observations showed that some students were less interested when the teacher started explaining, and sometimes they were unable to respond well during discussions. After conducting interviews and further observations, it was discovered that the teaching model employed by teachers was mainly discovery learning and rarely included problem-based learning (PBL), even though discussions, lectures, and practical work were frequently used. Additionally, the use of innovative digital teaching materials was limited as teachers were occupied with time-consuming administrative tasks, making it difficult for them to create digital teaching materials. Nevertheless, teachers were using appropriate teaching media, such as videos, images, PowerPoint presentations, and Student Worksheets, to effectively deliver the content. With the use of innovative teaching materials and appropriate instructional media, it is hoped that students can better understand the material and become more engaged in their learning.

One form of learning innovation today is integrated learning of local potential. Local Potential-Based Learning Innovation is one of the learning approaches that aims to optimize local potential or existing resources in a particular region or community (Malik & Mulyono, 2017). The purpose of this innovation is to improve the understanding and skills of students and teachers in fields that are in accordance with local potential. Integrating local potential in learning can also increase students' understanding of certain concepts. Local Potential-Based Learning Innovation can be an innovative and effective learning alternative, and can improve the quality of education by utilizing existing local resources (Fuadati & Wilujeng, 2019).

Learning innovation can also be done through the implementation of PBL models into teaching materials. The PBL model has been recognized for its effectiveness in improving environmental literacy in students. PBL enables students to identify and resolve

environmental issues through student-centered learning and involves collaboration between students and teachers (Liu et al., 2018; Merritt et al., 2017). PBL helps students to develop critical thinking skills, the ability to work together in teams, and problem-solving skills that are essential in facing environmental challenges. In addition, PBL also provides real and relevant learning experiences for students, as they work on environmental issues that affect their daily lives (Ural & Dadli, 2020). Therefore, the use of PBL learning models in environmental literacy learning can help students understand environmental issues and encourage them to take responsible actions for a better environment in the future.

Several research results show that integrated learning of local potential and PBL-based learning has a positive influence on learning outcomes. Putri & Aznam (2019), revealed that the integration of local batik uniqueness into online learning modules has a significant effect on students' thinking skills after using the module. In addition, another study by Sriyati et al (2022) showed that the use of learning tools based on local curd's uniqueness can help improve learners' science process skills. Similar findings were also expressed by Wilujeng & Suryadarma (2018), who found that the integration of local uniqueness in integrated science learning had a positive impact on students' science process skills and concept understanding. In addition, applying the PBL Model to learning can provide direct experience for learners to solve environmental problems, which can improve students' environmental literacy and creative thinking skills, as has been revealed in research by Ozsoy & Ertepinar (2012); Ulger (2013); and Widianingsih et al (2017).

Based on this explanation, it is assumed that the use of the Rawa Bento Integrated Science e-book can be an alternative solution in fostering students' environmental literacy. The e-book integrates various aspects of learning, from science to environmental literacy, using the PBL model. In learning using PBL, students will be more active and directly involved in solving problems related to their surroundings. In the e-book, students will be given various tasks and challenges to develop their environmental literacy skills. The Rawa Bento Integrated Science E-book is also equipped with a variety of interesting images and multimedia, so that it can help increase students' interest in learning. With the use of the e-book, it is hoped that students can better understand and get to know the environment around them, and can become a generation that cares and is responsible for the environment. Thus, the purpose of this study is to see how the level of environmental literacy of students after using the PBL-based Rawa Bento integrated science e-book in learning.

METHODS

Research Design

The research employed a quasi-experimental design with a pre- and posttest approach. The sample consisted of two classes, referred to as the modeling class and the implementation class. Both groups received identical treatments in the form of science learning facilitated by the PBL-based Rawa Bento integrated science e-book. However, a key difference lay in the teachers who conducted the instruction. This variation allowed for the assessment of how different teaching methods or styles influenced the effectiveness of the e-book in enhancing students' environmental literacy. By comparing the pre- and posttest results from both classes, the study aimed to evaluate the impact of the e-book and the teaching methods on students' environmental literacy levels.

Population and Sample

The population for this study consisted of 7th grade students at SMPN 6 Yogyakarta. From this population, a sample of two classes, totaling 60 students, was selected to participate in the research. These two classes, referred to as the modeling class and the implementation

class, were chosen using random sampling to ensure an unbiased selection process. This approach provided a balanced and representative sample for evaluating the impact of the PBL-based Rawa Bento integrated science e-book on students' environmental literacy. By using random sampling, the study aimed to enhance the validity and generalizability of its findings to the broader population of 7th grade students at the school, offering valuable insights into the effectiveness of this innovative educational tool.

Research Steps

The research process began with the development of the PBL-based Rawa Bento integrated science e-book, aimed at incorporating local potential into science education. Following this, instruments for data collection were developed to measure students' environmental literacy levels. A random sample of two classes, totaling 60 students from 7th grade at SMPN 6 Yogyakarta, was then selected. The study commenced with a pretest to establish baseline environmental literacy levels among participants. Subsequently, both the modeling and implementation groups underwent the learning process, which involved using the e-book for science instruction. Finally, a posttest was administered to evaluate any changes in environmental literacy following the intervention. This structured approach allowed for a comprehensive assessment of the e-book's effectiveness in enhancing students' understanding of environmental issues, utilizing local resources as a pedagogical tool.

Data Collection Instruments

The research instrument used to collect environmental literacy data for students is multiple-choice questions that have been tested for validity. Environmental literacy of students measured is seen from five environmental literacy indicators, namely (1) knowledge of environmental issues, (2) identification of environmental issues, (3) analysis of environmental issues, (4) planning actions to solve environmental problems. The collected data were then examined to see if there were any variations between the environmental literacy of the students in the modeling classes compared to the control classes before and after learning.

Data Analysis Techniques

The data analysis for this study involved using SPSS 21 to assess the changes in environmental literacy levels between the pretest and posttest values. To determine the magnitude of the difference, if any significant difference was found, the effect size was calculated using equation (1). This calculation provided a measure of how substantial the observed differences were, thereby offering deeper insights into the effectiveness of the PBL-based Rawa Bento integrated science e-book in enhancing students' environmental literacy. By quantifying the effect size, the study could better understand the practical significance of the educational intervention beyond mere statistical significance.

$$Cohen's d_z = \frac{M_{diff}}{\sqrt{\frac{\sum(x_{diff} - M_{diff})^2}{N-1}}} \quad (1)$$

RESULTS AND DISCUSSION

Results

Modeling

Environmental literacy data in the modeling class was obtained from the results of pretest and posttest in class VII A SMPN 6 Yogyakarta. In the modeling class, students are

given treatment, namely using the PBL-based Rawa Bento integrated science e-book taught by the model teacher (researcher). A descriptive comparison of the results of environmental literacy assessment before and after learning is presented as Table 1.

Tabel 1. Comparison of Environmental Literacy in the Modeling Class

	N	Minimum	Maximum	Mean	Std. Deviation
<i>Pretest</i>	26	20.00	100.00	63.0769	22.40879
<i>Posttest</i>	26	20.00	100.00	68.4615	21.29644

Based on the information presented in Table 1, it is evident that students in the modeling classes exhibited diverse levels of environmental literacy both before and after utilizing the PBL-based Rawa Bento Integrated Science e-book. The pretest scores ranged from 20.00 to 100.00, with a mean score of 63.0769 and a standard deviation of 22.40879. Following the intervention, the posttest scores also varied widely, ranging from 20.00 to 100.00, with a slightly higher mean score of 68.4615 and a standard deviation of 21.29644. These statistics indicate that while there was an overall improvement in environmental literacy levels after using the e-book, individual student outcomes varied, suggesting differing degrees of effectiveness in enhancing environmental knowledge and understanding among the modeling class students.

Differences in environmental literacy assessment results before and after learning can also be visualized through each environmental literacy indicator, as depicted in Figure 1. This figure provides a detailed comparison of how students' understanding and knowledge of environmental concepts evolved following their engagement with the PBL-based Rawa Bento Integrated Science e-book. By examining these indicators, such as knowledge of environmental issues, awareness of sustainable practices, and comprehension of local ecological contexts, educators and researchers can gain insights into the specific areas where students showed improvement or areas that may require further attention in future educational interventions. Figure 1 serves as a valuable tool for pinpointing the effectiveness of the e-book in enhancing environmental literacy among students in the study.

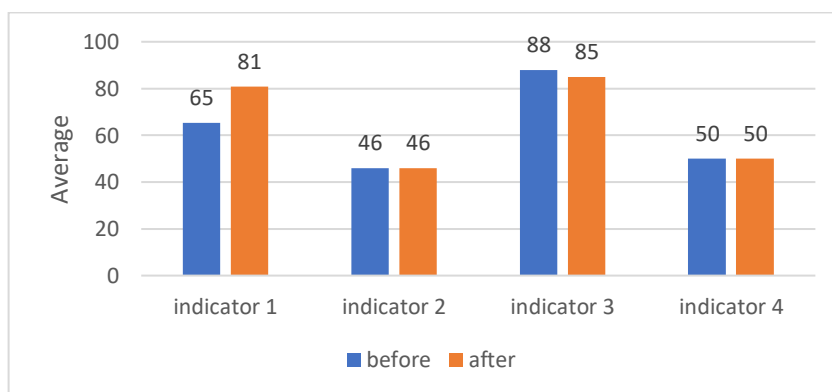


Figure 1. Results of Environmental Literacy Assessment of Modeling Class

The difference in the environmental literacy levels of the students in the modeling class was then examined using two average paired sample t-tests as a difference test. Based on the data analysis that was done, a sig (2-tailed) value of 0.317 is obtained. As a result, there is no discernible difference between students' environmental literacy before and after learning if the

value achieved is more than 0.05. Additionally, the Cohen's d score was calculated to determine how much environmental literacy had changed between before and after the implementation class. Cohen's d value of 0.20 suggests a small impact size based on computations.

Implementation

The same thing was done in the implementation class, namely the use of the integrated science e-book Rawa Bento in class VII B at SMPN 6 Yogyakarta. However, in this case, control is given to the teacher who teaches, namely the science subject teacher in the class who is assumed to have known the characteristics of students thoroughly. A descriptive comparison of the results of environmental literacy assessment before and after learning in modeling classes is presented as Table 2.

Table 2. Comparison of Environmental Literacy Implementation Classes

	N	Minimum	Maximum	Mean	Std. Deviation
<i>pretest</i>	24	20.00	80.00	49.1667	17.67254
<i>posttest</i>	24	20.00	100.00	61.6667	21.19612

Based on the data in Table 2, there are differences in environmental literacy levels between before and after learning in the implementation class. The pretest results showed the average value of environmental literacy of students was 49.1667 while in the posttest it was 61.6667. The difference is also shown in the maximum value obtained by learners. In the pretest activity, students obtained a maximum score of 80.00, while in the posttest activity, the maximum value was 100.00. The results of the analysis of the level of environmental literacy of students on each indicator are presented in Figure 2.

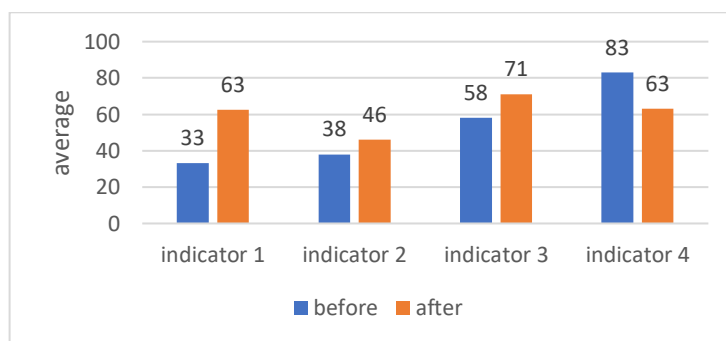


Figure 2. Results of Environmental Literacy Assessment Classroom Implementation

The environmental literacy of students has increased in every indicator in the implementation class. The highest increase was in the 1st indicator, namely knowledge of environmental issues. Furthermore, the environmental literacy data of students in the implementation class were analyzed using the paired sample t-test so that a GIS (2-tailed) value of 0.008 was obtained. Thus, it can be interpreted that there is a significant difference between students' environmental literacy before and after the use of PBL-based Rawa Bento integrated science e-books.

Furthermore, the calculation of Cohen's d score was carried out to measure the extent of the difference between environmental literacy before and after learning in the implementation class. Based on calculations, Cohen's d value of 0.58 indicates a moderate effect size. In this

context, the difference between pretest and posttest scores is quite significant and has a moderate impact.

Discussion

The use of Rawa Bento's integrated science e-book has a positive effect on the environmental literacy of junior high school students. In the modelling class, there are differences in the environmental literacy of students who use the e-book guided by the model teacher (researcher). However, the significance of the difference between environmental literacy before and after the use of e-books did not show any noticeable difference. This can happen because of the teacher who teaches. In addition to teaching materials used in learning, the role of teachers in determining learning outcomes is very important. Teachers have the responsibility to create a conducive learning environment, facilitate students' understanding, and motivate them to learn (Suyitno, 2021).

In the implementation class, the average difference between pretest and posttest results showed a significant difference. This indicates that the use of PBL-based Rawa Bento integrated science e-books supported by science subject teachers who understand the characteristics of students can have a positive impact on improving students' environmental literacy. The size of the effect exerted on the implementation class belongs to the medium category. This shows that the use of PBL models using PBL-based Rawa Bento integrated science e-books can significantly affect the improvement of students' environmental literacy. In other words, the use of PBL models is able to provide direct experience to learners in solving environmental problems, which in turn can improve their environmental literacy skills.

The findings in this study show that the PBL-based Rawa Bento integrated science e-book can improve students' environmental literacy. But there is another factor, namely the teacher who teaches. Competent teachers can identify the needs and level of individual understanding of students. They are able to modify learning approaches, adopt appropriate strategies, and provide appropriate assistance to ensure that students truly understand the material. With a better understanding of students, teachers can overcome learning difficulties, optimize the learning process, and improve student outcomes. So that, in indicator 3 in the modeling class and indicator 4 in the implementation class, there is resistance to changes or decreases in scores. Students and teachers may experience resistance to the changes brought about by the innovation of teaching materials. They may already be familiar with previous learning methods and have difficulty adapting to new approaches. This can affect students' skills and understanding in the material being taught.

The integration of local potential into teaching materials as done can attract students' interest and motivation to learn more about the environment. The importance of integrating local potential into teaching materials in the context of learning is that it can attract students' interest and motivation to learn more about the environment. When learning materials are presented using contexts and realities that are close to students, they tend to be more interested and motivated to learn in the end encouraging students to become more interested and sensitive to environmental issues thus improving their environmental literacy skills (Carlina & Djukri, 2018). By integrating local potential into teaching materials, students will see the relevance and practical value of what they learn in their daily lives (Khairani et al., 2023; Putri

& Aznam, 2019b). They can observe and study the environment around them directly, recognize the uniqueness and richness of the local environment, and understand the impacts and challenges faced by the environment around them (Khairani et al., 2023). In addition, the integration of local potential also opens up opportunities to actively involve students in the learning process (Fahlevi et al., 2023). For example, students can conduct research, field observations, or participate in environmental projects related to their local potential. This will provide hands-on experiences that strengthen their understanding of the environment and give them a sense of belonging to their environment.

The positive impact of this e-book is also influenced by the PBL model. PBL-based e-books have an impact on environmental literacy which can be seen from the increase in students' environmental literacy results after participating in learning. PBL is recognized as an effective approach in improving students' environmental literacy, especially when integrated with local environmental issues (Suryawati et al., 2020). The PBL learning process can shape knowledge and attitudes that have an impact on students' ability to understand themselves and their environment, so that they can understand environmental problems (Amin et al., 2020; Kim, 2021; Wajdi et al., 2022a). through this model Learners are actively involved in solving relevant and contextual environmental problems, using the knowledge and skills they learn (Gündüz et al., 2016; Wajdi et al., 2022b). This process helps learners develop a deeper understanding of environmental issues, as well as improve their ability to analyze, evaluate, and take action on environmental issues. This finding is consistent with the results of previous studies that also show the positive impact of the PBL model on environmental literacy. A study by Siddiq et al (2020) found that learners who engaged in PBL-based learning experienced significant improvements in environmental literacy. In the context of this study, the PBL model may be effective in improving environmental literacy due to its active, contextualized, and integrating problem-solving approach.

CONCLUSION

Based on the results of the study, it can be concluded that the use of the Rawa Bento integrated science e-book had varying effects on students' environmental literacy in different classroom settings. In the modeling class, there was no significant difference observed in environmental literacy before and after using the e-book, indicating minimal impact (Cohen's $d = 0.20$). Conversely, in the implementation class, there was a significant improvement in environmental literacy after using the e-book ($\text{sig} < 0.05$), with a moderate effect size (Cohen's $d = 0.58$). These findings suggest that integrating the PBL-based Rawa Bento e-book into classroom instruction effectively enhances students' environmental literacy, particularly when actively implemented as part of the learning process. Further research could explore broader applications of the e-book across diverse educational contexts to refine its implementation strategies and maximize educational benefits.

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