Problem-Based Learning Assisted by Mobile Pocket Book in Mechanical Wave to Enhances Students' Concepts Mastery and Creativity

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Abstract – *The research aims to determine the influence of the model problem-based learning assisted by a mobile pocket book mechanical wave to increasse students' concepts mastery and creativity. The type of research is quasi-experimental and uses a nonequivalent control group design with pre-test and post-test. Population at this study included all students of class XI IPA at SMAN 4 Mataram Academic Year 2022/2023. Samples were taken using purposive sampling technique, so that XI IPA 1 is obtained as an experimental class as many 32 people and XI IPA 2 as control class as many 31 people. Results the final test of concepts mastery obtained an average score of 78.70 in the experimental class and control class 68.81. Meanwhile, the results of the final creativity test obtained an average value of 80.79 for the experimental class and 76.02 for the control class. The hypothesis was analyzed using Manova with the help of IBM SPSS 21. Based on the results of the analysis it can be concluded that there is the influence of the problem-based learning model assisted by the mobile pocket book mechanical wave to increasse students' concepts mastery and creativity.*

Keywords*: Problem-Based Learning; Mobile Pocket Book; Mechanical Wave; Concept Mastery; Creativity*

INTRODUCTION

The continuous development of science and technology is expected to influence Generation Z in the field of education, particularly in the use of internet-based information for learning. Technology is reshaping the objectives of education, including curriculum changes. Curriculum is an educational program that systematically includes teaching materials designed based on applicable standards and serves as a guideline for teachers in creating learning experiences to achieve educational goals (Dakir, 2012:2).

The development of elaborative learning, which encompasses attitudes, knowledge, and skills (Sopyan & Komariah, 2016), is a demand of the curriculum. Technological advancements can be effectively integrated into the learning process through the use of models and learning media. The use of technology can create innovative and effective teaching methods that make learning enjoyable for students (Ramadhany, et al., 2015). The use of models and media can diversify the learning process, motivate students to actively engage, and promote their independence and creativity.

A preliminary study conducted through classroom observations of 11th-grade physics classes at SMA Negeri 4 Mataram revealed that physics education in the classroom still largely relies on the teacher. Students' limited participation in the learning process has led to suboptimal comprehension of physics concepts and underutilization of media in teaching.

Observations of students' creative thinking skills during the learning process showed that they were primarily engaged in asking and answering questions posed by the teacher. Consequently, students' physics learning outcomes in the 11th-grade IPA

(Science) class were below the minimum passing criteria (KKM) of 70.

The limited independence and creativity of students are due to the inadequate development of skills obtained in the classroom. Passive participation in learning leads students to focus solely on the concepts presented by the teacher, resulting in low problem-solving abilities (Azizah, 2019).

To address these issues, efforts should be made to involve students more actively in developing ideas related to physics concepts. One teaching model that meets these criteria is problem-based learning. This teaching model enhances students' critical thinking skills, leading to concepts mastery and creativity in solving physics problems, ultimately improving students' learning outcomes. Problem-based learning provides students with an opportunity to build their understanding of concepts by addressing real-life problems (Juahari et al., 2016).

According to Dewi et al. (2016), problem-based learning can be used to deliver material and develop creativity in solving problems, thereby enhancing students' mastery of physics concepts. Research by Niami et al. (2018) indicates that problem-based learning can improve students' understanding of physics concepts because students are confronted with real-world problems that encourage active learning and discussion with peers. Several studies have also shown that problem-based learning enhances students' creativity and concepts mastery in the learning material (Muslim, et al., 2015; Siska et al., 2015; Raihan et al., 2020).

Problem-based learning is centered around students and presents them with everyday problems to stimulate creativity in problem-solving and effective communication in new ways (Starko, 2010). Moreover, problem-based learning provides students with longer-lasting knowledge compared to conventional learning methods (Widiastuti et al., 2021). The use of appropriate teaching models significantly impacts the learning process, and the use of supportive learning media is necessary to optimize teaching and learning activities.

Using media as a teaching aid simplifies the process of conveying information and involves students in solving physics problems. The rapid advancement of technology in education has introduced various learning media that support the teaching and learning process. According to Noviatika et al. (2019), one such learning medium in education is the use of mobile or Android smartphones in the form of pocket books, which can serve as an engaging and non-boring learning media.

The use of a pocket book allows students to learn independently. The presented material is engaging and concise without compromising the concepts that need to be understood, and it can be taken anywhere (Umam et al., 2015). Mobile pocket books come with exercises or evaluations that can serve as enrichment, and they include animations that support the material, making learning more engaging for students (Rini et al., 2020). However, mobile pocket books typically contain summarized content that covers only sub-topics in physics. Therefore, there may be limitations in terms of the amount of physics material that can be effectively applied using this learning media, and some smartphones may not support animated displays.

A problem-based learning model supported by mobile pocket book for mechanical waves will simplify students' ability to solve problems related to abstract physics concepts and create an enjoyable learning experience. According to Muffidah & Hasanah (2022), physics mobile pocket books are flexible and easy to carry around, making it convenient for students to learn independently. The use of learning media greatly assists students in understanding the material, and the concept presentation in the mobile pocket book for mechanical waves can capture students' attention through animations or simple experiment videos. This aligns with the findings of Khamzawi (2015), who stated that the ease and practicality of using virtual media can facilitate students' comprehension of the learning material.

To address the above-mentioned issues, the researcher was motivated to conduct this study using a problem-based learning model supported by a mobile pocket book for mechanical waves, with the hope that students would become more active, independent, and find physics learning enjoyable. The research aims to determine the influence of the problem-based learning model supported by the mobile pocket book for mechanical waves on enhancing students' concepts mastery and creativity.

RESEACRH METHODS

The research employed a quasi-experimental design known as the non-equivalent pretest-posttest control group design. Both samples, the experimental group and the control group, underwent pre-tests and post-tests. The subjects of the study were 11th-grade IPA (Science) students at SMAN 4 Mataram in the second semester of the academic year 2022/2023. The sampling technique used was purposive sampling, with the researcher's specific considerations. The selection of the samples was based on the following criteria: similar physics class schedules for both classes, a relatively equal number of students in both classes, and both classes being taught by the same teacher. The selected samples consisted of 32 students in the experimental group (XI IPA 1) and 31 students in the control group (XI IPA 2).

The experimental group received treatment using the problem-based learning model supported by the mobile pocket book for mechanical waves, while the control group received instruction using the direct instruction model with the same teaching material, which is mechanical waves.

The mobile pocket book for mechanical waves was developed by Amani (2021) using MIT App Inventor and can be downloaded from a website. The instruments used to measure concept mastery were multiple-choice tests, and the instruments used to measure creativity were essay tests. The questions in both concept mastery and creativity tests were validated, assessed for reliability, and evaluated for difficulty level and discrimination power. The concept mastery test consisted of 18 multiple-choice questions, while the verbal and figural creativity tests each included 7 essay questions.

The results of the concept mastery and creativity test data were subjected to preliminary analysis, including tests for homogeneity and normality. The hypothesis in this research is whether there is an influence of the problem-based learning model supported by the mobile pocket book for mechanical waves on improving students' concepts mastery and creativity in the subject of mechanical waves. The hypothesis was tested using multivariate analysis of variance (Manova) with the assistance of IBM SPSS 21 software.

RESULTS AND DISCUSSION

The research aims to determine the influence of the problem-based learning model assisted by the mobile pocket book for mechanical waves on enhance students' concepts mastery and creativity. The research employed a quasi-experimental design, with the experimental group receiving the treatment of problem-based learning supported by the mobile pocket book for mechanical waves in XI IPA 1 consisting of 32 students, and the control group undergoing direct instruction in XI IPA 2 consisting of 31 students.

The research outcomes were measured through pretest and posttest scores for concept mastery and creativity. The average creativity scores between the pretest and posttest for both the experimental and control groups were examined. The average creativity score in the pretest for both groups was as follows: 72.58 for the experimental group and 68.75 for the control group. After the treatment, the average posttest scores for both groups showed improvement compared to the pretest. The average posttest concept mastery score for the experimental group was 80.79, categorized as high, while it was 76.02 for the control group. Although both groups had high average posttest creativity scores, the experimental group had a higher average posttest creativity score compared to the control group. The results of the average scores for both groups in the pretest and posttest for concept mastery and creativity can be seen in Table 1.

Table 1. The average scores for the Pretest and Posttest of Concept Mastery and Creativity

	Group	($\bar{X}$) Pre-Test	($\bar{X}$) Post-Test
Concept Mastery	Experimental	40,27	78,70
	Control	36,01	68,81
Creativity	Experimental	72,56	80,79
	Control	68,78	76,02

The next step involves conducting a Manova test to determine whether the problem-based learning model supported by the mobile pocket book has a simultaneous influence on improving students' concepts mastery and creativity in the subject of mechanical waves. Manova is a statistical test that measures the impact of an independent variable on multiple dependent variables on a quantitative scale (Ghozali, 2013). The Manova statistical test has two prerequisite tests: the Levene's test to assess variance homogeneity and the Box's M test to examine the variance/covariance matrix. The significance results of both of these prerequisite tests should be greater than 0.05 for the Manova test to proceed.

The two prerequisite tests of Manova, namely the Levene's test and the Box's M test, can be found in Tables 2 and 3.

Table 2. Homogenies Test Using *Levene's Test*

Dependent Variable	Sig.
Concepts Mastery	0,684
Creativity	0,900

The Levene's test results indicate that the F-value for concept mastery is 0.167, and the F-value for creativity is 0.016. The significance for concept mastery is 0.684, and the significance for creativity is 0.900. If a significance level of 0.05 is set, then the significance for concept mastery and creativity is greater than 0.05. This means that the variance in the concept mastery and creativity of the participants is homogeneous. Therefore, the MANOVA (Multivariate Analysis of Variance) test can be continued.

Table 3. The Results of Box's M test

Box's M	0,409
F	0,132
df1	3
df2	693137.195
Sig	0,941

The Box's M test results show a significance value of 0.941 for both concept mastery and creativity. When applying a significance level of 0.05, 0.941 > 0.05, indicating that the concept mastery and creativity of the participants have the same variance/covariance matrix. Therefore, the MANOVA test can proceed.

Based on the analyses of both Levene's test and Box's M test, both yielded significance levels greater than 0.05, allowing for the continuation of the MANOVA test. The MANOVA test is employed to examine whether there is an influence of problem-based learning assisted by mobile pocket book on mechanical wave on both concept mastery and creativity of participants simultaneously. The Roy's Largest Root is used for the test since the homogeneity of variance/covariance is satisfied. The results of the Roy's Largest Root can be observed in Table 4.

Table 4. the results of MANOVA test

Effect	Sig.
Roy's Largest Root	0,00016

Based on the results of the MANOVA test using IBM SPSS 21, the Roy's Largest Root test yielded a significance level of 0.00016, which is smaller than the significance level of 0.05. This indicates that the alternative hypothesis (Ha) is accepted, suggesting an influence of problem-based learning assisted by mobile pocket book on mechanical waves on both concept mastery and creativity of participants simultaneously.

The experimental group, which implemented problem-based learning assisted by a mobile pocket book on the topic of mechanical waves, showed an improvement in concept mastery and creativity compared to the control group, which applied direct instruction. The treatment given to the experimental group had a positive impact.

The learning process in the control group using the direct instruction model was found to be suboptimal due to factors such as the teaching approach that tends to be teacher-centered. This resulted in less active participation from students and consequently lower levels of concept mastery and creativity.

The use of problem-based learning demands active involvement from students in addressing presented issues. The advantages of problem-based learning include fostering critical thinking and problemsolving skills. Additionally, this research utilized instructional media, specifically a mobile pocket book on the topic of mechanical waves, which supported students in improving their concept mastery and creativity. The use of this model proved effective in motivating students during the learning process, as evidenced by the positive responses from the experimental group. Students found that concepts in physics were easier to understand through the mobile pocket book, enabling them to independently solve the problems presented.

A mobile pocket book, or technology-based pocket-sized book on mobile phones, is one of the products of mobile learning (m-learning). It is small in size, containing concise materials that can be carried anywhere and accessed anytime (Umam et al., 2016). The stages of the problem-based learning model assisted by the mobile pocket book on the topic of mechanical waves can contribute to improving the concept mastery and creativity of students. The concept mastery of students can be facilitated through the use of the mobile pocket book as a learning medium for the material on mechanical waves. This allows students to collaboratively solve problems in groups, actively exchanging ideas with their groupmates to find answers provided by the researcher. This aligns with the findings of Kurniawati et al. (2020), who stated that learning media can guide students to solve problems by presenting questions relevant to everyday life.

In the experimental class, Learning Kits (LKPD) were used, while the control class used Learning Devices (LDPD), both in group settings to solve problems presented by the researcher. During the syntactic investigation phase, the experimental class solved problems in the LKPD with the assistance of the mobile pocket book on the topic of mechanical waves, while the control class was provided with LDPD for problem-solving using printed books.

The activities showed that the experimental class was more motivated in learning due to the use of technological tools compared to the control class accustomed to using printed books for problem-solving activities in the classroom. The use of media aids in fostering active student participation in physics learning, creating an enjoyable learning atmosphere (Pramudyawan et al., 2019).

Below is Figure 1, an example of a problem on the topic of wave refraction presented in the form of LKPD, and Figure 2, a summary display of wave refraction material on the mobile pocket book on the topic of mechanical waves.

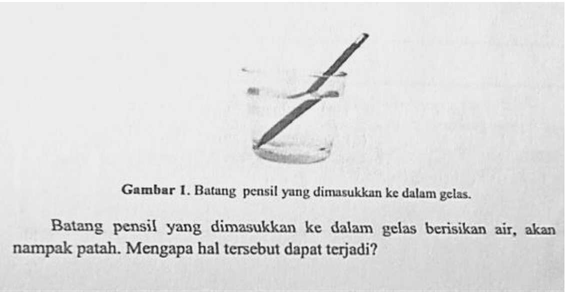

Figure 1. Example of problems in the experimental group on the topic of wave refraction

Based on the investigation stage of the group using LKPD, the students' concepts mastery C1-C6 showed improvement. This progress is evident when students can successfully solve given problems, facilitated by the use of the mobile pocket book on the topic of mechanical waves as a learning media tool. Hastuti et al. (2016) stated that problem-based learning with the assistance of virtual media in the problem orientation stage makes it easier to understand the material with the presence of animated displays. This proves that problem-based learning with media assistance can develop thinking skills and enhance students' concepts mastery (Utami, 2020).

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Figure 2. Display of a summary of material on wave refraction in the mobile pocket book on the topic of mechanical waves

Creativity skills measured in this study include verbal and figural creativity. The figural creativity of students can be observed in solving problems in the LKPD, such as drawing patterns of wave forms from simple experiments aided by the mobile pocket book on the topic of mechanical waves.

Here is Figure 3, showing the material on wave interference in the mobile pocket book on the topic of mechanical waves, and Figure 4, an example of the resulting pattern of wave interference in the experimental class.

Figure 3. Display of the summary of wave interference material on the mobile pocket book on the topic of mechanical waves

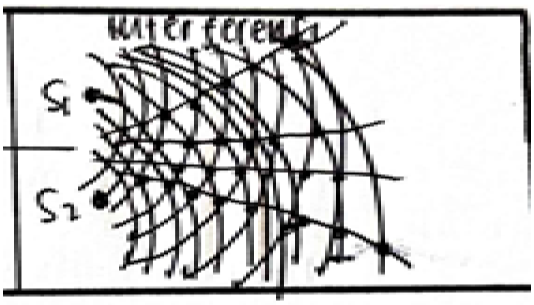

Figure 4. Example of the resulting pattern of wave interference in the experimental group

Based on Figure 4, students in the experimental class demonstrated good figural creativity in developing ideas through shapes or drawings. Presenting problems in the form of LKPD with the assistance of learning media, such as the mobile pocket book on the topic of mechanical waves, fosters students' creativity by encouraging them to find solutions autonomously. Indriani et al. (2023) stated that mobile learning can enhance students' creativity, influencing them to generate new ideas and present engaging animations of virtual objects.

Through the use of media in learning, Generation Z students can easily learn physics through technology accessed via the internet. This aligns with Gunawan's research (2015), which indicated that technology use can help improve students' understanding, especially in abstract physics learning, through interactive multimedia.

Based on observations in the classroom during the use of the mobile pocket book on the topic of mechanical waves, it can be effectively utilized by students, motivating them and serving as an alternative for physics learning to enhance students' concepts mastery and creativity.

However, there are limitations to the use of this learning media. Some students may face difficulties downloading or installing it due to the minimum Android version requirement (2.3). Adequate preparation for learning activities aligned with the intended goals is crucial. Time allocation for learning activities and ensuring that the application is downloaded on smartphones before the lesson is essential.

CONCLUSION

Based on the research findings and discussions, it can be concluded that there is an effect of problem-based learning model assisted by the pocket book in mechanical waves to enhance the concepts mastery and creativity of students.

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