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Interactive Learning Media Oriented Problem-Based Learning to Improve Students Mathematical Problem Solving Skills

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ABSTRAK

Pentingnya penggunaan media pembelajaran pada pembelajaran matematika agar pembelajaran lebih menarik nyatanya belum dioptimalkan, pembelajaran masih konvensional yang berpengaruh kepada rendahnya kemampuan pemecahan masalah matematika siswa. Penelitian ini mengembangkan media pembelajaran interaktif berorientasi problem based learning yang dirancang untuk meningkatkan kemampuan pemecahan masalah matematika siswa. Prosedur penelitian yang digunakan adalah prosedur dari Plomp yang terdiri dari 3 fase yaitu, Fase Preliminary Research, Fase Prototyping, dan Fase Assesment. Subjek penelitian adalah dua orang validator, serta sebanyak 26 siswa pada uji coba terbatas, 35 siswa pada uji coba lapangan I dan sebanyak 43 siswa pada uji lapangan II. Hasil produk adalah media pembelajaran interaktif berorientasi problem based learning yang berkualitas valid, praktis dan efektif. Kualitas produk memperoleh rata-rata score 3,60 dengan kategori sangat valid, berkualitas praktis dari segi respon siswa ,respon guru dan keterlaksanaan media pada pembelajaran di kelas, serta berkualitas efektif dalam meningkatkan kemampuan pemecahan masalah matematika siswa dibuktikan dengan gain-score dengan kategori cukup efektif.

ABSTRACT

The importance of using learning media in mathematics learning so that learning is more interesting has not been optimized, learning is still conventional which affects the low ability to solve students' mathematical problems. This research develops interactive learning media oriented to Problem-Based Learning designed to improve students' mathematical problem-solving skills. The research procedure used is the procedure from Plomp which consists of 3 phases, namely, the Preliminary Research Phase, the Prototyping Phase, and the Assessment Phase. The subjects of the study were two validators, as well as 26 students in the limited trial, 35 students in field trial I, and as many as 43 students in field test II. The result of the product is an interactive learning media oriented to problem-based learning that is of valid, practical, and effective quality. Product quality obtained an average score of 3.60 with a very valid category, practical quality in terms of student response, teacher response, and media implementation in classroom learning, and effective quality in improving students' mathematical problem-solving skills as evidenced by gain-score with a fairly effective category.

1. INTRODUCTION

Problem-solving ability is an important component of the mathematics curriculum and one of the indicators of success in learning mathematics, because in solving problems not only learn concepts but emphasize thinking skills (Nurfatanah et al., 2018; Nurjanah & Jusra, 2020; Septian et al., 2022). Mathematical problem-solving ability is the attempt to find ways to solve mathematical problems based on mathematical concepts, skills, and processes. In the process of solving mathematical problems, students are encouraged to determine solutions and develop strategies in solving problems (Nurjanah & Jusra, 2020; Khafidatul, 2020). Students who have problem-solving skills will be able to identify the elements known, asked, and the adequacy of the necessary elements, able to create or compile mathematical models, able to choose and develop solving strategies, able to explain and check the correctness of the answers obtained (Rohmatulloh & Nindiasari, 2021; Mustafia & Widodo, 2018; Sumartini, 2018). With problem-solving skills, students will be able to solve real-life situations in mathematical models. In addition, improved problem-

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solving skills will improve students' own math learning outcomes, and thus will advance the quality of mathematics education (Simamora et al., 2017; Fatmasari et al., 2022). Seeing the importance of mathematical problem solving skills, problem solving should be given, trained, and familiarized to students as early as possible (Wardhani et al., 2022;Rambe & Afri, 2020).

The problem that occurs is that students' mathematical problem solving skills are relatively low. Based on a study from the Programme for International Student Assessment (PISA) in 2018 where the study compared the math skills from 79 countries. The results of studies that have been published state that Indonesian mathematics is ranked 73 out of 79 countries (Argina et al., 2017; Tohir, 2019). In recent years, studies related to students' problem-solving skills have become a research trend due to the urgency of math students' math problem-solving abilities for students. Some studies show that the average test results of students' math problem solving ability are in the low category (Cahyaningsih et al., 2021; Rambe & Afri, 2020; Riyadi et al., 2021). Literature reviews related to students' mathematical problem-solving abilities show that students' problem-solving abilities at all levels are still low, this is because students do not have a complete concept. It can be a concern for educators to develop effective learning designs in improving problem-solving skills (Hadi et al., 2023; Septian et al., 2022).

Based on observations, it shows that the learning that occurs is still conventional, lacking training in students' problem-solving skills through contextual problems. The use of learning resources also only uses textbooks, the use of learning media in supporting the representation of mathematical concepts has also not been optimized. Learning that is still conventional with its implementation dominated by teachers causes the learning process to involve students less so that students are less skilled in solving a problem (Komalasari, 2020; Lestari et al., 2019; Suhita Lestari et al., 2020). In addition, teachers' lack of understanding of the right media and lack of teacher creativity to create creative and interesting media for students make students less interested in paying attention to mathematics learning (Ayu et al., 2021; Parastuti Lestari et al., 2022; Wulandari et al., 2023). The development of learning needed is creative and innovative learning that provides a conducive climate in the development of students' reasoning power and problem-solving abilities (Fitri, 2023; Magdalena et al., 2021).

The solution to overcome students' low mathematical problem solving ability is to develop interactive learning media oriented to Problem Based Learning. The use of media in the teaching and learning process is needed for optimal achievement of learning objectives (Fariz & Dewi, 2022; Nurmawati et al., 2020; Tambunan et al., 2021). Interactive learning media has been proven to have a good impact on student learning processes and outcomes. The good impacts include: 1) creating an interactive and fun mathematics learning process, 2) dismissing the paradigm of some people who consider mathematics subjects as difficult and confusing subject matter, and 3) increasing student achievement (Damayanti & Qohar, 2019; Irfani et al., 2017; Mahuda et al., 2021). The preparation of interactive learning media for students will refer to the steps and rules of Problem Based Learning so that it can be more focused in an effort to improve students' mathematical problem solving skills. Problem-based Learning is a model to make students active in learning (Nurbaeti, 2019; Zainal, 2022). This model challenges students to solve a problem from the real world (Hendriana et al., 2018; Simamora et al., 2017). The syntax of this learning model is to direct students to problems, guide students in investigating problems, and actively seek solutions to these problems (Juhari & Muthahharah, 2020; Lestari et al., 2019). So that the development of interactive learning media with problem-based learning orientation will be a good combination to focus on improving students' mathematical problem solving skills.

Some relevant research includes research from suggests that to increase understanding in solving a problem, students using multimedia are very effective in learning mathematics seen from the level of effectiveness, which is 80% through problem-solving ability tests (Eka et al., 2022). Other research from which results in Problem Based Learning presented in interactive multimedia has a good influence, seen from students who are more excited and enthusiastic about learning using interactive multimedia (Novi Andria Caesariani, 2018). The advantage of this research is that the learning media developed will provide students freedom in learning anywhere and anytime and train students' active roles in learning and problem solving. The novelty of this study contain features contained in the media are not made only limited to teaching materials, but interactive features that contain routine and non-routine problems that students must solve to train the process of solving student math problems. The purpose of this development research is to develop interactive learning media that are valid, practical and effective in improving students' mathematical problem solving abilities.

2. METHOD

This research is a type of design research whose theory refers to design research (Robinson, 2016). Based on this theory, there are three phases in design research which include: preliminary research,

prototyping, and assessment. In the preliminary research phase or the initial study phase contains needs analysis and learning analysis. The prototyping phase or development phase contains a test of the effectiveness of the resulting product (getting the final product). The cycle process of analysis, design and development, evaluation, and revision for design quality improvement and implementation refinement. The assessment phase contains a test of the effectiveness of the resulting product (getting the final product).

The subjects of the study were class XI students of SMK N 1 Klungkung with details of class XI BKM as many as 26 students in limited trials, class XI AKKL I as many as 35 students in field trials I and class XI OTKP I as many as 43 students in field trials II and involving two learning media validators. Media quality is tested based on the level of validity, practicality and effectiveness. The data analysis technique used to determine the validity of learning media is descriptive analysis, by calculating the average acquisition of media validation assessment scores and then converting based on the following categories is show in Table 1.

Table 1. Validity Score Categories

Interval	Categories
$3.5 \leq \bar{x} \leq 4.0$	Very Valid (Very Decent)
$2.5 \leq \bar{x} < 3.5$	Valid (Worthy)
$1.5 \leq \bar{x} < 2.5$	Invalid (Infeasible)
$1.0 \leq \bar{x} < 1.5$	Very Invalid (Very Infeasible)

Then the data analysis technique used to determine the practicality of learning media is similar to the technique in validity analysis, namely calculating the average score of student response questionnaires, teacher response questionnaires and media implementation sheets then converted based on predetermined criteria. Then to determine the level of effectiveness in terms of increasing students' mathematical problem solving ability is analyzed using a gain score test. The calculation results using the above formula can be interpreted with the adaptation of the classification as show in Table 2.

Table 2. N Gain Classification

N Gain score	Interpretation	Effectiveness Rate
g>0.70	High	Effective
0.30<g<0.70	Medium	Quite Effective
g≤0.30	Low	Less Effective

Qualitative data analysis techniques are used for observation and interview data. Qualitative data in the form of expert comments and advice as well as data on the results of media effectiveness in the form of problem-solving abilities (Sukmana & Suartama, 2019).

3. RESULT AND DISCUSSION

Result

The development of interactive learning media using the stages of design research by the theory proposed by Plomp there are three phases in development research which include: the preliminary research stage, the development stage (prototyping), and the assessment stage (assessment). The initial investigation phase consists of needs analysis and learning analysis. The results of the analysis shows in the learning process is still predominantly teacher-centered, lack of available learning resources for students, lack of learning media that attract students to learn, students' mathematics problem solving exercises are less optimal and lack of use of technology in learning.

The second stage is this development stage, this stage researchers design the product developed in the form of Interactive Learning Media Oriented Problem Based Learning (PBL). Interactive learning media is developed using the Articulate Storyline 3 application which will produce media in the form of Android applications, which will be installed on students' smartphones. Learning media contains various features including learning videos, LKPD, interactive quizzes, graphic exploration, material summary, and evaluation. Android app main menu display is show in Figure 1.

Figure 1. Android App Main Menu Display

The preparation of material in the media is adjusted to the core competencies and basic competencies in the 2013 curriculum, the preparation of material is also adjusted to the results of learning analysis that adjusts to the characteristics of students. The features provided in the learning media are designed to support the training of students' mathematical problem solving skills such as interactive learning video features for student independent study, LKPD features containing HOTS problems used at the group investigation syntax stage, interactive quiz features, function graph exploration, and evaluation. Learning menu display is show in Figure 2.

Figure 2. Learning Menu Display

Learning media that has been designed produces Prototype I which is tested for validity by two learning media experts. The results of the media validation test is show in Table 3.

Table 3. Summary of Learning Media Validator Results

Validators	Average Score	Average Total Score	Category
Validator 1	3.6	3.60	Highly Valid
Validator 2	3.6		

Referring to the results of Table 3 from each validator gave a score with an average score of 3.60, namely the learning media developed meets the very valid category. The validation results are not only in the form of scores, but there are also results in the form of corrections to suggestions and inputs that are used by researchers as a basis for revision or perfecting products, the results of product revisions are referred to as Prototype II which will be tested on a limited basis to get an idea of how the implementation of media in learning. Each stage of the trial consists of planning, implementation, observation and evaluation as well as reflection. Prototype II was tested on 26 students during 4 meetings. In limited trials, assessing in terms of practicality through learning implementation sheets, teacher response questionnaires and student response questionnaires. The average overall score for the media implementation sheet in the limited trial was 3.14 which was classified as a practical category, the student response questionnaire obtained an average score of 3.29 in the practical category and the teacher response questionnaire obtained an average score of 3.53 in the very practical category. In limited trials, an evaluation process was also carried out to improve the media for the better, this resulted in Prototype III. Prototype III was tested in a wider trial, namely field trial I with respondents as many as 35 students to test the media in terms of practicality and effectiveness. Field trial I was carried out as many as 7 meetings, which obtained the average result of the media implementation score was 3.24 with the practical category, the student response questionnaire obtained an average score of 3.32 which was classified as practical, while the teacher

response questionnaire obtained a score of 3.80 which was classified as very practical. In field trials I obtained effectiveness results, namely gain-score results of 0.48 which are classified as quite effective in improving students' mathematical problem solving abilities. The results of reflection / evaluation in field trials I are used to revise the product to produce Prototype IV which is ready to be tested at the next stage, namely the assessment stage.

The assessment phase was carried out by carrying out field trials II using prototype IV, field test II consisting of 43 students. The focus of field trials II is to obtain a quality, valid, practical and effective final product. In terms of the results of the student response questionnaire obtained a score of 3.42 which was classified as the Practical category, while the teacher response questionnaire obtained a score of 3.86 which was classified as Very Practical. The learning media implementation sheet produced an average score of 3.29 which was classified as Practical. In terms of effectiveness, a gain-score of 0.53 was obtained, which was classified as quite effective in improving students' mathematical problem solving skills. From the implementation process, students are enthusiastic about the use of media, and students try to solve the problems provided. From the results of the interview, it was obtained that students felt that the media really helped them in learning, in terms of teachers, teachers saw that the media was able to support students' active involvement in learning. The effectiveness of the media can be seen from the ability to solve students' mathematical problems, in measuring students' mathematical problem solving abilities based on problem-solving indicators according to Polya, that it understanding the problem, compiling a resolution plan, implementing the solution plan and re-examining. In the post-test results, it can be seen that there is an improvement in terms of Student problem-solving ability, where initially Student could not solve the problem on the pre-test. However, in the Post-test, Student I has been able to solve the problem with appropriate and complete problem solving steps according to the solving steps from Polya. In general, other students experience the same thing, namely an increase in problem-solving skills.

Discussion

Interactive learning media oriented to Problem Based Learning can improve students' mathematical problem solving skills. First, problem-based learning makes learning more meaningful, because students are actively involved in the problem-solving process. Meaningful learning is that students can be actively involved in utilizing their minds to form concepts in the problem-solving process (Carolina Santi, Arnoldus Helmon, 2021; Mulyati, 2016). Problem-based learning increases student learning activities, assists students in solving learning problems through direct experience, improves the ability to apply concepts to new / real problems so that it has implications for academic achievement (Finisia et al., 2018; Nalurita et al., 2019; Simamora et al., 2017).

Second, problem-based learning-oriented learning media has various features such as interactive learning videos, LKPD, exploration sections, and evaluations that contain various problems so as to support training in developing students' problem-solving skills. To acquire problem-solving skills, one must have a lot of experience in solving various problems (Mahuda et al., 2021; Nurfatanah et al., 2018). Other study that support include the results of research that producing interactive learning media can improve students' mathematical problem solving skills because the media has elements including text, audio, video, animation, and graphics and allows students as users to explore or develop their thinking skills (Fariz & Dewi, 2022; Hayati & Amri, 2022; Irfani et al., 2017). Interactive learning media based on problem-based learning adds to the effectiveness of the media in terms of increasing problem-solving abilities, this is in line with the results of research stated that the five stages of the problem-based learning model combined with technology can provide better problem-solving skills students (Fariz & Dewi, 2022; Novi Andria Caesariani, 2018).

Third, interactive learning media makes students more interested and enthusiastic in learning mathematics and increases students' understanding of mathematical material. Learning is more interactive because the media is not only passive but actively provides responses and accommodates student responses. The process of learning mathematics using interactive learning media is superior than conventional learning, learning becomes fun, students feel more interested in learning and not just listening and memorizing (Kusumawati & Mustadi, 2021; Riyanto & Gunarhadi, 2017). Through interactive learning media, students not only see images and hear but can give an active response. Some of the advantages of using interactive multimedia are that it consists of various media formats (multiple representations), encourages active student participation, students can start learning flexibly; and can provide a more meaningful learning experience (Suarsana et al., 2019; Herliana, 2020; Hayati & Amri, 2022). Learning media facilitate interaction between teachers and students so that learning activities are more effective and efficient as well as teaching aids that also affect the climate, conditions and learning environment (Cahyanti & Dra. Sumarsih, 2017; Nurfadhillah et al., 2021; Suryawan & Permana, 2020). Learning mathematics using media is a way or as learning that is preferred by students because mathematical concepts can be presented

more interestingly, thus increasing student understanding of the material presented (Cahyanti, 2017; Yanti et al., 2019).

Fourth, interactive learning media oriented problem-based learning is also developed with the closest thing of students right now, namely in the form of Android applications installed on students' smartphones. Learning media in the form of Android applications makes students more interested, motivated and able to learn independently, this is because students are accustomed to using mobile phones in their daily lives, so that learning becomes more flexible can be done anywhere and anytime (Afifah et al., 2022; Irfani et al., 2017; Sari & Ardianti, 2021). It can be concluded that interactive learning media oriented to problem-based learning developed results in improved problem-solving skills, positive student responses and learning becomes more enjoyable. The implication of this research is that problem-based learning-oriented learning media can be used to train mathematical problem solving skills, and this research can be used as a reference to develop other innovative mathematics learning.

4. CONCLUSION

This research has succeeded in developing interactive learning media oriented to Problem Based Learning that produces valid, practical and effective criteria. This study provided results in an increase in students' mathematical problem solving skill. Learning using interactive learning media oriented to problem-based learning provides the progression of how students solve problems with appropriate and complete steps, interactive learning media is able to provide meaningful learning experiences by increasing student activeness and active involvement in building knowledge, training their mathematical problem solving skills so that they are very well applied in mathematics learning.

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