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Developing Interactive Media Based On Problem-Based Learning To Improve Students' Mathematical Understanding

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Abstrak

Penelitian ini bertujuan mengembangkan media pembelajaran interaktif berbasis Problem Based Learning untuk meningkatkan pemahaman matematis siswa. Adapun jenis penelitian yang digunakan adalah Research and Development (R&D) dengan model pengembangan ADDIE (Analysis, Design, Development, Implementation, Evaluation). Hasil penelitian menunjukkan bahwa pengembangan media interaktif berbasis problem based learning untuk meningkatkan pemahaman matematis siswa dinyatakan 1) Valid, dengan perolehan skor rata-rata dari penilaian validasi media sebesar 92,7% (81%≤x≤100%) termasuk kedalam kategori sangat valid, 2) Praktis, berdasarkan angket respon guru yang diberikan kepada dua orang guru, diperoleh penilaian sebesar 98% (81%≤x≤100%) tergolong sangat praktis, dan berdasarkan angket respon siswa diperoleh penilaian sebesar 87,21% tergolong sangat praktis. 3) Efektif, hal ini ditinjau berdasarkan ketuntasan belajar klasikal sebesar 88,2% (≤85% siswa memperoleh nilai ≥76) termasuk kedalam kategori efektif, tercapainya indikator pemahaman matematis ditinjau dari terjadi peningkatan dari pretest ke postest pada setiap indikator pemahaman matematis yang digunakan.

Kata kunci: *Media, PBL, Pemahaman_Matematis*

Abstract

This study aims to develop interactive learning media based on Problem Based Learning to improve students' mathematical understanding. The type of research used is Research and Development (R&D) with the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation). The results of the study indicate that the development of interactive media based on problem based learning to improve students' mathematical understanding is stated as 1) Valid, with an average score of 92.7% (81%≤x≤100%) included in the very valid category, 2) Practical, based on the teacher response questionnaire given to two teachers, an assessment of 98% (81%≤x≤100%) is classified as very practical, and based on the student response questionnaire, an assessment of 87.21% is classified as very practical. 3) Effective, this is reviewed based on classical learning completion of 88.2% (≤85% of students obtained a score of ≥76) included in the effective category, the achievement of mathematical understanding indicators is reviewed from the increase from pretest to posttest in each indicator of mathematical understanding used.

Keywords: Media, PBL, Mathematical_Understanding

1. INTRODUCTION

Interactive learning media has significant potential to stimulate pupils to respond favourably to the provided learning material. Interactive media is media that can respond to user reactions. Interactive media can be generated from a combination of numerous media, including computers, photos, videos, and text, and can be called interactive multimedia(Simanullang et al., 2025:86). By employing interactive learning media, teachers no longer have to explain and explain course material simply through lectures in front of the class, as this might lead to student boredom (Yulianti & Novtiar, 2023:2041). The usage of interactive learning media in schools can be considered as a progressive step in responding to technology advances and simultaneously as a strategy of supporting its use to improve the quality of education (Siregar et al., 2021:89). By including interactive aspects, students are not only passive users of information connected to the content but also become active participants in the learning process.

The utilization of learning aids is a standard for success in mathematics learning. Learning media, which responds to learning models, plays a crucial part in the success of teaching and learning mechanisms. This is not merely a supporting tool but also a valuable component that can enhance the quality of learning, boosting students' mathematical knowledge and helping them reach optimal learning outcomes (Sari et al., 2021:15). This method enables pupils to solve difficulties by applying their prior knowledge. According to Haety & Putra (2022:99), Problem Based Leaning (PBL) can educate students in applying critical thinking, problem-solving skills, and their knowledge to contextual, real-world problems and challenges. To find solutions to these challenges, students are asked to obtain the relevant data and information from multiple sources. Problem-based learning has an engaging impact on students because it encourages them to think independently about problems offered by the teacher (Hidayat & Maulida, 2022:26). The problem-based learning methodology has various benefits, including strengthening problem-solving skills, conceptual understanding, critical thinking skills, and reaching targeted learning goals.

However, in fact, numerous challenges are still identified in mathematics learning, as shown in research that studied "Problems in implementing the Merdeka Belajar curriculum in mathematics learning at SMKN 2 Pacitan." From the research, it was determined that the mathematics learning process was perceived adversely by pupils who found it challenging (Oktavia et al., 2023:23). This is impossible due to issues affecting kids, instructors, parents, schools, and education support. These factors include students' lack of math imagination, inaccurate learning methods, boring learning media, monotonous learning processes, schools without learning support facilities, teachers' inability to incorporate IT into learning mechanisms, and students' lack of independent learning. In line with Manik's (2022:329) opinion, the readiness of human resources and supporting facilities is a very important factor in realizing independent learning in accordance with the independent curriculum.

This is shown by the researcher's initial ability exam (diagnostic test) provided to class X-18, which will be employed as study subjects during observations at MAN 1 Medan to assess students' mathematical knowledge. The initial diagnostic test (ability test) provides students three questions that assess their arithmetic understanding. The diagnostic exam designed to assess mathematical concept understanding includes three indicators: restating a concept, selecting and using appropriate procedures or operations, and applying concepts or algorithms to solve problems. Diagnostic tests examine students' mathematics understanding using questions like. Analysis of students' answers in completing the mathematical comprehension ability test questions above can be seen in the following table.

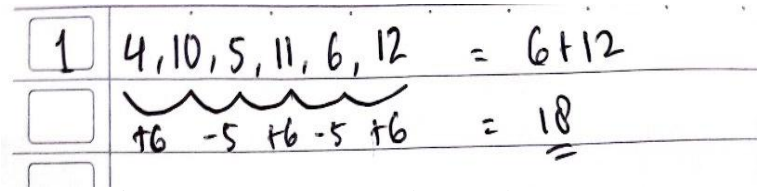


Figure 1. Answers to Diagnostic Test No. 1

Based on the students' answers to question number 1, it can be seen that there are students who have not answered the question correctly according to the mathematical understanding indicator. Judging from the first indicator, namely restating a concept, it can be seen that students have not been able to understand the concept. This is because students do not first make things that are known and asked based on the questions presented, such as the value of a, the value of b, and n. Furthermore, this indicator was not fully met because the information was written incompletely, making it difficult for students to understand and find the appropriate information in the questions (Marlinda & Budiman, 2025:163). Then, reviewed from the second indicator, namely using and utilizing and choosing certain procedures or operations, it can be seen that students' mathematical understanding is relatively low, because students have not been able to use the formula to find the difference of an arithmetic sequence, namely $b = U_2 - U_1$ (Susanto, 2021:37). In addition, if reviewed from the third indicator, namely applying concepts or algorithms in problem solving, it is still relatively low because students immediately answer the final result without connecting it to the events answered in the question, students should be able to make the final result such as "Data on bookstore visitors in the first 6 days formed a pattern, namely 4, 10, 5, 11, 6, 12. This indicator is achieved when students are able to solve problems correctly so that they can make the right decisions according to the concept of the problem that they understand (Mulyani et al., 2024:2228).

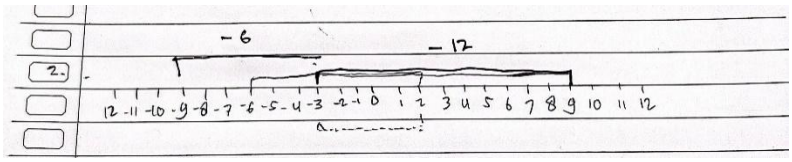


Figure 2. Answers to Diagnostic Test No. 2

Based on students' answers to question 2, it's evident that some replied incorrectly and got the wrong answer. Restating an idea shows that some students still don't get it. The reason is that pupils do not initially construct items that are known and requested depending on the questions offered, such as how many original marbles they have, how many are decreased and added, and the remaining marbles. The second sign, applying and utilizing and picking certain processes or operations, shows that certain students cannot solve problems and make number line calculations correctly. The third sign, using concepts or algorithms in problem solving, is also poor because pupils do not link the questions in the problem to the final outcome. This situation explains that there is still a low level of mathematical understanding among students, which is indicated by the lack of accuracy of students when understanding the concept of the problem and the students' doubts when explaining their answers, which is measured in the third indicator (Wahidah & Hakim, 2022:75).

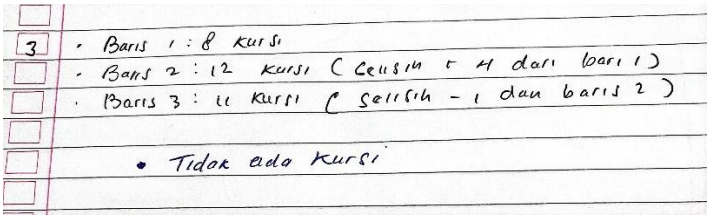


Figure 3. Answers to Diagnostic Test No. 3

Students' partial answers to question 3 indicate that some have not replied correctly. Students use the improper initial concept, resulting in a wrong answer. Based on the first indicator, students can

state known concepts but struggle with arithmetic sequences, including grasping the values of a, U_2, U_3, U_4, U_5, value of b and the question. Second, using and utilizing and selecting certain procedures or operations, it appears that students are not yet able and do not understand how to determine the type of number pattern and the number of chairs presented in the question, so they cannot calculate the difference in chairs. For the third indicator, applying concepts or methods in problem solving, pupils apply the notion incorrectly, therefore they cannot answer the question. The results obtained are in line with Rismen's (2021:124) opinion that students do not have a good enough mathematical understanding, because students are unable to organize and develop other ideas to solve the problem completely. It was apparent that students had difficulty finding the final result based on the solution steps, and their execution methods were not yet precise, preventing them from finding the final result. Students' habit of memorizing problems without understanding the concepts and material was the main cause of their errors, resulting in students only understanding one type of problem (Hartati, 2021:91).
Depending on the student's answer method, they may not have used all the right solutions. Based on the diagnostic test results for class X-18 MAN 1 Medan students, 34 were selected. According to the table above, 5 students (14.7%) had very good abilities, 16 students (47%), 12 students (35.2%), 1 student (2.9%), and 0 students (0%) had poor abilities. The average score for indication 1 (restating a concept) is 68.3%, which is high. In the aspect of using, utilizing, and selecting certain procedures or operations, 4 students (11.7%) had very good abilities, 16 students (47%), 13 students (38.2%), 1 student (2.9%), and 0 students (0%) had poor abilities. The average result for indicator 2 (using and picking certain methods or operations) is 22.75%, which is poor.

The results of the diagnostic test are in line with the research findings in the research that explores "Analysis of mathematics learning problems and alternative solutions at SMP Negeri 1 Rambang" from the research it was found that the problems of mathematics education at SMP Negeri 1 Rambang are 1) low understanding of mathematical concepts, which causes students to lack basic knowledge for learning mathematics from previous classes, 2) low mathematical understanding, which causes many students to have difficulty understanding the material in mathematics, 3) the absence of learning media that can improve students' mathematical understanding, resulting in low students' mathematical understanding, and 4) the application of learning methods that are not in line with students' characteristics (Meliyani, 2021:1722). This is supported by the results of observations at the school, especially for students of class X MAN 1 Medan, it was found that many students of class X still find the material in mathematics difficult. The low mastery of these concepts makes it easy for students to make mistakes. This can be proven by the lack of concentration of students in paying attention to the teacher when explaining mathematics lessons, as well as the low mathematical understanding of students in this subject.

Mathematical understanding ability is an ability that needs to be instilled in students in learning mathematics because building understanding in every mathematics learning activity will develop the mathematical knowledge that students have, so that mathematical understanding is an important foundation for thinking in solving mathematical problems and in real life (Zakiamani et al., 2020:212). For this reason, teachers must innovate in developing their professional competence in creating a quality learning process by designing learning tools, especially learning media (SC et al., 2020:803). But, based on information obtained from the researcher's interview activities with mathematics teachers of class X, especially X-18, it was found that learning tools have not been implemented thoroughly during the mathematics learning process. Teachers tend to only use teaching materials in the form of textbooks from the school, LKPD (Student Worksheets) and UKBM (Independent Learning Activity Units), as well as assessments in the form of practice questions or quizzes given as learning evaluations. This media is needed because it can overcome the weaknesses of conventional media which are only informative, encourage students to think actively, not just memorize, provide a more meaningful learning experience according to the demands of the modern curriculum. The difference with existing media is that information is presented directly (text, video, presentations) and passively, only receiving material.

In general, in solving arithmetic sequence problems, students only memorize the steps for solving that the teacher teaches, so this factor is one of the reasons why students are not yet able to understand the concept (Marella & Fiangga, 2024:187). The learning process in the classroom must help students to practice their mathematical abilities, one of which is that students can be actively involved in learning, while the teacher acts as a facilitator by using learning media as a learning support tool (Rengganis & Hidayat, 2025:328). Meanwhile, the use of learning media is rarely used by teachers when explaining mathematics lessons. This is because teachers more often use direct learning models, and teachers feel that using media in mathematics learning will make learning time feel short and insufficient to understand the material. This situation makes it difficult for students to understand the material being taught because it doesn't involve real-life experiences, leading many to only know the formulas but not the concepts. Based on the descriptions of mathematics learning issues in the previous section, it is necessary to find solutions to the problem of students' understanding of mathematics.

2. METHOD

This research is included in development research, with the type of research used R&D (Research and Development). In using the ADDIE development model, there are 5 stages, namely analysis, design, development, implementation, and evaluation (Slamet, 2022:26). This research was conducted at one of the Senior High Schools (SMA) in Medan, namely MAN (State Madrasah Aliyah) 1 Medan, precisely in Building 2 which has an address at Jalan Pertiwi Number 19, Medan Tembung District, Medan City, North Sumatra Province. This research was conducted in the even semester of the 2025 academic year. The subjects used in this study were students of class X-18 MAN (State Madrasah Aliyah) 1 Medan in 2025. Then for the object in this study is interactive learning media based on the PBL (Problem Based Learning) model with the help of Articulate Storyline 3 to improve students' mathematical understanding:

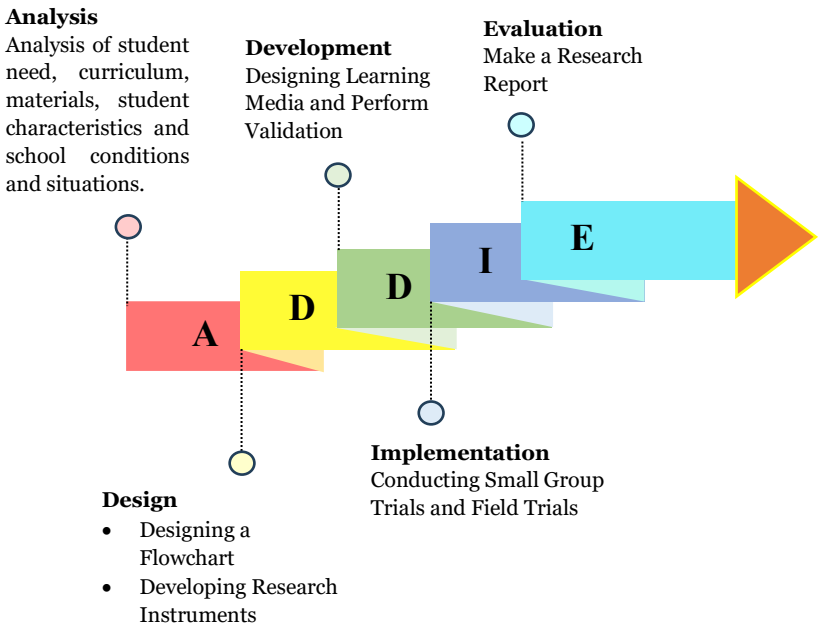


Figure 4. Stages of the ADDIE Development Model

The ADDIE (Analysis, Design, Development, Implementation, Evaluation) method was chosen for the research on developing interactive media based on Problem-Based Learning because it is more

systematic and simpler than other R&D methods, such as Borg & Gall, which has 10 complex steps. ADDIE provides a clear flow, from needs analysis, media design, product development, field trials, to evaluation and revision. ADDIE's advantages include: each stage can be evaluated and revised before moving on to the next, resulting in a more effective, efficient, and user-friendly product. Furthermore, this model is highly relevant for developing technology-based learning media due to its emphasis on the instructional design cycle, which focuses on learning objectives, student characteristics, and expected learning outcomes.

Therefore, the ADDIE method was chosen over other models because it is practical, structured, easy to implement, and appropriate for the context of developing interactive media to improve students' mathematical understanding.

3. RESULT AND DISCUSSION

The use of learning media in the classroom has become an essential part of teachers' teaching practice. In everyday experience, many teachers utilize simple media such as whiteboards, textbooks, or PowerPoint presentations to help explain concepts. However, some teachers feel that the media used are still static and do not fully support active learning. This often leaves students as passive listeners, without broader opportunities to engage in the process of exploring concepts. Teachers generally recognize that learning media can increase student motivation and understanding, but limited technological knowledge, time, and access to innovative media are major obstacles. Their experience shows that while conventional media are quite helpful in delivering material, they are not able to optimally foster critical thinking and problem-solving skills. In this context, teachers urgently need media that not only present material but also encourage students to interact, think deeply, and relate concepts to everyday life. Therefore, the development of interactive media based on Problem-Based Learning (PBL) is considered relevant, as it can address teachers' needs while supporting the achievement of mathematics learning objectives that emphasize conceptual understanding and problem-solving skills.This research and development aims to produce a product and determine the development, feasibility, practicality, effectiveness and implementation of interactive learning media assisted by Articulate Storyline 3 (Sukmawarti & Murwaningsih, 2024:216). The interactive media product was designed using Articulate Storyline 3 with an application output that students can access via Android phones or laptops, both online and offline. In its development, the researchers used the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation. The results of each stage of the interactive learning media development can be described as follows:

Analysis

The first stage of the ADDIE development procedure is the analysis stage. This stage is carried out to identify problems that occur in the mathematics learning process (Sukmawarti & Murwaningsih, 2024:217). In this stage, the researcher directly observed the school to determine student learning needs, the curriculum, current and future materials, student characteristics during teaching and learning, and the school's conditions and situation. Interactive learning media had never been employed in mathematics, and many pupils still lacked attentiveness while the teacher explained the content. Interviews with mathematics teachers showed that they used lecture methods, textbooks, and student workbooks. Sometimes only PowerPoint slides were utilized by teachers to teach. Thus, teachers enthusiastically embraced the researcher's interactive medium.

Problem Based Learning (PBL) in mathematics can also be combined with learning media. Learning media is intended to present abstract mathematical concepts explicitly and concretely (Rohmatulloh et al., 2022:5545). Thus, problem-based learning-based interactive media is necessary to improve students' arithmetic comprehension. The interactive media was created with Articulate Storyline 3 to accommodate students' increased use of mobile phones and electronics. The interactive media results are an app students can use on Android smartphones, laptops, or PCs online and offline. A

school scenario study was done to gather data for research. Direct observation showed that Building 2 of MAN 1 Medan has suitable facilities, including an InFocus and Wi-Fi for technology-based learning. The school administration in Building 2 of MAN 1 Medan welcomed the researcher throughout her observations. Integrating problem-based learning into interactive media to increase students' math comprehension helped the researcher. The researcher used Articulate Storyline 3, which has never been used as a math instruction medium, to generate compelling media for pupils.

Design

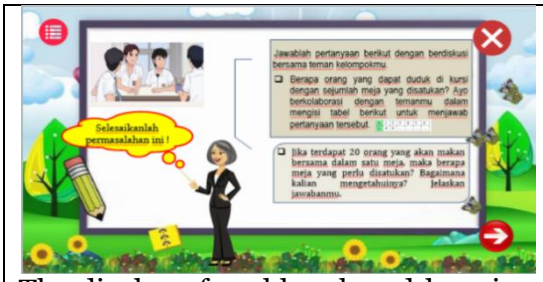
This design stage is the stage where the form or design of the media is determined, which is done by designing a storyboard, flowchart and research instrument (Febriyandani & Kowiyah, 2021:327). The interactive media form is designed during the design process. This phase will also construct problem-based learning-based interactive media components to verify validity, practicality, and efficacy. This design phase involves:

1. Designing media essentials based on observation and interview results from the previous step. Interactive media components match Arithmetic Sequences and Series essential abilities and markers of mathematical understanding. The interactive media will present materials, associated issues, quiz questions, and reinforcement of comprehension from the prepared components.
2. Designing interactive media icons, button icons, accompanying graphics, backgrounds, soundtracks, sound effects, etc.
3. Designing a flowchart as a flow of an interactive media developed through Articulate Storyline 3. In the flowchart designed by the researcher, a description of the media and its components will be made from the first display to the last display. In the research conducted, it was divided into 4 meetings where meetings 1 and 2 were conducted with direct learning models, while meetings 3 and 4 were conducted using interactive media developed based on problem-based learning models.

The developed media is suitable for use in the learning process, but the media, which has been validated by the validator, received some suggestions regarding the selection of media backgrounds and button placement. The results of the researchers' findings are as follows:

Table 1. Learning design display

Before Revision	After Revision
 The background display is too busy, so the words are not clear..	 The background display is simple, so it can be seen clearly.

 The display of problem-based learning questions is not clear enough, and it would be better to illustrate the questions more clearly.	 The display of problem-based learning questions is clear and has been made into illustrations so that the interactive elements are visible.

Development

Development, the third stage of this inquiry, takes two steps. This research objective requires researchers to prepare learning tools like teaching modules, LKPD, research instruments (validation sheets, student and teacher response questionnaires, pretest and posttest questions, and mathematical understanding questions), and most importantly, interactive problem-based learning media. Then, the second step that needs to be done in this development stage is to validate the questionnaire, validate the media, validate the material and validate the questions. At this stage, interactive multimedia is created that will be used in accordance with the flowchart and storyboard designs that have been prepared previously using Articulate Storyline 3 and the development product is converted into an application with the help of Website 2 APK Builder Pro v3.0 software (Dewi Astri et al., 2022:581). The data from the validation results are:

Table 2. Recapitulation of Validation Results

No	The object being assessed	Average total validation value	Validation Level
1.	Material Validation	89,7	Valid
2.	Media Validation	92,7	Valid
3.	Questionnaire Validation	96,6	Valid
4.	Validation of Pretest and Posttest Questions	90,8	Valid
5.	Validation of Learning Devices	90	Valid
6.	Validation of Students' Mathematical Understanding Questionnaire	95,3	Valid

Based on the validation assessment of students' mathematical understanding obtained from several validators, it was found that the average percentage of the designed student mathematical understanding questionnaire obtained a value (81%≤x≤100%) which is included in the "very appropriate" category. A questionnaire is a data collection method that involves providing written questions to respondents to answer. In this study, the questionnaire was used to determine students' satisfaction levels with mathematics learning using interactive media based on Problem-Based Learning (Febriyandani & Kowiyah, 2021:252). Therefore, the student mathematical understanding questionnaire that will be used as a guideline in the learning process is appropriate.

Implementation

After the interactive problem-based learning media, teaching modules, and questions in this study meet eligibility criteria and are revised by the researcher, this implementation step follows. The

researcher's interactive problem-based learning media will be tested for practicality and effectiveness, as well as students' mathematical grasp. The implementation phase uses small and big sizes. The small-scale test included six 10th-graders and the large-scale test included all 34 class X-18 pupils. The purpose of this large-scale trial was to determine the practicality and effectiveness of the developed interactive media product. The practicality of the multimedia product was determined through a student response questionnaire. The effectiveness of the interactive multimedia product was determined through a student learning outcome test (Muzakkir et al., 2022:87).

The interactive problem-based learning media for 18th-grade research courses covered arithmetic sequences and series. Students installed the researcher's media application to directly access the generated material. The media helped students understand arithmetic sequences and series, complete interactive problems, quizzes, puzzles, and view researcher-presented problem solving films. The questionnaire was scored using a Likert scale, which requires respondents to answer questions with one of the available answers. Students were asked to mark (√) only the answer choices provided (Trisnawati et al., 2022:252) . Students will receive a media response questionnaire to fill out and score: 5 "Very Appropriate"; 4 "Appropriate"; 3 "Quite Appropriate"; 2 "Less Appropriate"; and 1 "Not Appropriate". To determine how the media affects kids, researchers conducted interviews with closed-ended "yes" or "no" questions. The implementation stages are described below.

In this study, the reference for achieving mastery is the Minimum Mastery Criteria (KKM) determined by the school, namely 76. Therefore, students are said to have completed learning if they have a score of ≥76. Based on the table displayed previously, the classification and percentage of learning mastery can be seen as follows.

Table 2. Percentage of Learning Completion

Description	(Pretest)		(Postest)	
Completed	9	26,4%	30	88,2%
Incomplete	27	79,4%	4	11,7%
Total	**34**	**100%**	**34**	**100%**

Then, to find out the percentage comparison of students' understanding of mathematical concepts, you can see the diagram below.

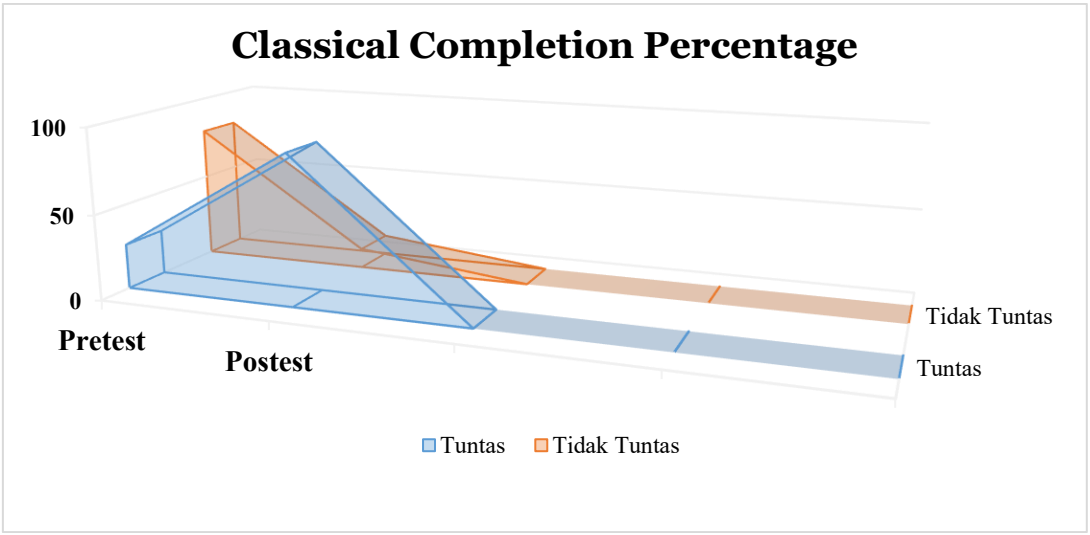


Figure 5. Classical Completion Percentage Diagram

Based on the description of the pretest and posttest score results that have been given to 34 students of class X-18 MAN 1 Medan, it can be seen that the percentage of student learning completeness in the pretest is 26.4% of students who are classified as complete, while 79.4% of students are classified as incomplete. Then the results of student scores on the posttest are 88.2% of students who are classified as complete, while 11.7% of students are classified as incomplete. Thus, the completeness of student learning outcomes in the field test has been achieved, where the classical completeness of students reviewed in the posttest score results reached 88.2%, which means that it has met the requirements for effectiveness based on learning completeness, namely if 85% of students get a score of ≥76.

Interactive problem-based learning media used to improve mathematical understanding in grade 10 students at MAN 1 Medan can be seen in the learning process, which follows the developed teaching module and the pretest and posttest results. The learning method uses material that matches math indications. Analyzing each indicator and pretest and posttest results using the N-Gain method can reveal students' mathematics conceptual comprehension improvements. Uji Gain skor digunakan untuk menentukan besarnya efektifitas dari penggunaan multimedia interaktif berbasis smartphone yang dilihat dari hasil belajar peserta didik sebelum dan setelah penggunaan produk multimedia (Muzakkir et al., 2022:85). The following table shows pupils' mathematics conceptual understanding improvement scores.

Table 3. Improvement in Mathematical Understanding

Description	Pretest	Postest	Improvement
Highest Score	85	100	15
Lowest Score	14,25	68,5	54,25
Average Score	**46,2**	**85,8**	**39,6**

Thus, the average increase in students' mathematical understanding abilities can be seen in the following diagram:

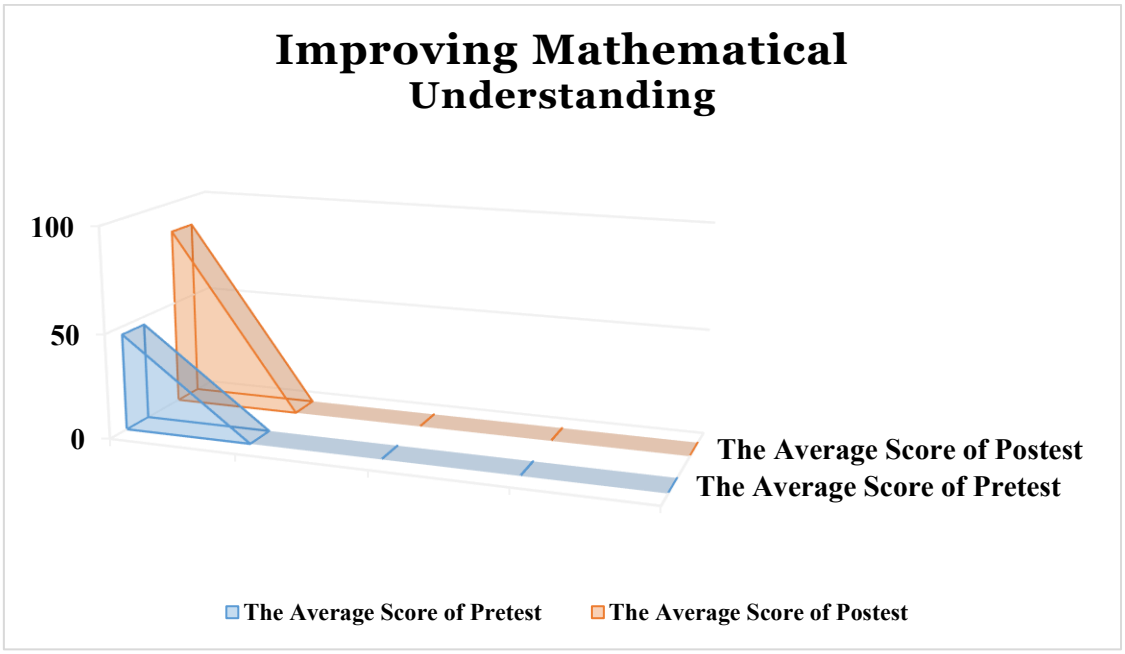


Figure 6. Diagram of Mathematical Understanding Improvement

Based on the diagram above, it can be seen that the average calculation of students' mathematical understanding obtained in the pretest was 46.2, which experienced an increase in the average mathematical understanding of 39.6 so that the average mathematical understanding in the posttest of students obtained a value of 85.8.

Based on the results of interviews and questionnaires given to students after using interactive media based on Problem Based Learning (PBL), the responses obtained were generally positive. Most students stated that they liked this learning media, because it had an attractive appearance, was easy to use, and helped them understand mathematical concepts through real-life problems relevant to everyday life. Students stated that interactive features such as animations, quizzes, and problem-based exercises made learning more enjoyable and less boring. They felt more active in thinking and motivated to find their own solutions. However, there were some students who did not like this media, citing that using the media took longer than conventional learning, and that they had difficulty understanding the initial instructions when first using the media. However, after being given guidance, students were able to adapt and began to enjoy the learning process with the media. Overall, student responses indicated that interactive media based on PBL was effective and engaging, and could increase their motivation and mathematical understanding.

Evaluation

At this stage, researchers conducted several analyses based on suggestions and input from students and teachers after using the interactive multimedia application in a large-scale trial (Muzakkir et al., 2022:87). Validation is carried out based on suggestions obtained from UNIMED Mathematics lecturers who validated the learning aids and interactive media during evaluation. This evaluation includes media validation sheets, material validation, pretest and posttest question validation, and teaching module validation. We checked the validity score and asked for feedback to improve the learning media.

Valid means fit for use. The validity of a product is determined by the validity of the quality of the media content, the technical aspects of the media, and the quality of the learning and instructional aspects. (Dewi et al., 2023:556). Memenuhi validitas isi berarti produk yang dalam hal ini media pembelajaran interaktif dikembangkan telah sesuai aspek yang telah ditentukan. The media validation percentage was 92% with a "very reasonable" validity criterion after updating the learning aids and interactive media based on validator feedback. A "very reasonable" validity criterion yielded 91.5% material validation. Also, pretest and posttest question validation was done with a "very reasonable" 93% validity threshold. Researchers conducted practicality tests with teachers and students after validating with UNIMED Mathematics lecturers. These practicality tests showed that interactive problem-based learning media was suitable for learning. Mrs. Sri Wahyuni S.Pd., M.Pd and Mrs. Isra Meriana Hasibuan, S.Pd, grade X mathematics teachers at MAN 1 Medan, scored 98% (81%≤X≤100%) with a "Very Practical" practicality score in their assessment. Additionally, the student answer sheet indicated 87.21% (81%≤X≤100%) practicality within the "Very Practical" category for interactive media focused on problem-based learning. It may be concluded that MAN 1 Medan uses interactive media focused on problem-based learning to improve students' mathematical comprehension.

Next, we can review the improvement in students' mathematical understanding based on the indicators used in this study. The results of the improvement in students' mathematical conceptual understanding were obtained based on pretest and posttest scores, each of which contained indicators of mathematical understanding, as follows:

Table 4. Improvement of Mathematical Understanding Indicators

No.	Mathematical Concept Understanding Indicators	*Pretest*	*Postest*	Improvement
1.	Restate a concept	55,3%	84,5%	29,2%
2.	Use, utilize, and select specific procedures or operations	51,8%	89,8%	38%
3.	Apply concepts or algorithms in problem-solving	44,4%	80,3%	35,9%

Based on the table, it can be seen that there is an increase in each indicator of students' mathematical understanding from pretest to posttest, namely 1) In the indicator of restating a concept, there is an increase of 29.2%, namely from 55.3% to 84.5%; 2) In the indicator of using and utilizing and selecting certain procedures or operations, there is an increase of 38%, namely from 51.8% to 89.8%; 3) In the indicator of applying concepts or algorithms in problem solving, there is an increase of 35.9%, namely from 44.4% to 80.3%.

DISCUSSION

The results of the study indicate that the interactive problem-based learning (PBL)-based learning media for mathematics learning on arithmetic sequences and series to improve students' mathematical understanding met the criteria for validity, practicality, and effectiveness. The media validation assessment components, namely appearance and design, content, and technical aspects, were assessed by three validators and obtained an average score of 92%, categorizing them as "very valid." Several validators assessed the appropriateness of the content, language, and presentation, resulting in a "very valid" validity score of 91.5%. The validity score for the pretest and posttest questions, assessed by the validators based on concepts, language, and question construction, reached 93%, categorizing them as "very valid." This is in line with research by (Wulandari, 2022) which found that implementing PBL with digital media significantly improved junior high school students' mathematical problem-solving abilities compared to conventional methods.

Finally, the validity of the questionnaire instrument was tested from three perspectives: language, formative writing, and content, with the validators obtaining a "very valid" score of 94%. Therefore, the questionnaire responses sent to students and instructors can be used to measure the practicality of the media. Data from 34 questionnaire responses from 10th-18th grade students assessing the practicality of interactive problem-based learning (PBL) media developed by researchers to improve students' mathematical understanding yielded an average practicality score of 87.21%. This is in line with research by (Hidayat, W., & Sariningsih, 2018), who stated that PBL-based interactive media enables students to be more active in discussions, think critically, and connect mathematical concepts to everyday problems. According to the practicality assessment rules, a score of $80\% \leq X \leq 100\%$ indicates a "Very Practical" status. This interactive media can be used to teach arithmetic at MAN 1 Medan. This study used the Minimum Completion Criteria (KKM) score of 76 at MAN 1 Medan to measure student learning mastery. Based on the post-test scores from the field trial, this score met the classical mastery criteria for mathematical understanding. The test, administered to 34 students, resulted in 30 students completing the test (88.2%) and 4 students completing the test (11.7%). The completeness of student learning outcomes in the field trial was met, with classical completeness of 88.2% in the post-test results, meeting the effectiveness requirements of 85% of students who obtained a score of ≥76. Thus, interactive media based on problem-based learning to improve students' mathematical understanding has met the learning mastery standards.

The implications of this research are: first, interactive PBL-based media can be a solution to address students' low mathematical understanding. Second, this media encourages a shift in the teacher's role from instructor to facilitator, resulting in more student-centered learning. Third, this type of media can be an innovative alternative in mathematics learning in the digital age, while also addressing curriculum needs that emphasize critical thinking, creativity, and problem-solving skills. Thus, this research strengthens the evidence that integrating learning technology with a PBL approach can have a positive impact on the quality of mathematics education.

4. CONCLUSION

The following describes the results obtained from the research that has been carried out, namely: Three validators found interactive problem-based learning media for boosting pupils' mathematical comprehension to be 92% "very valid." This suggests that the problem-based learning media is legitimate and suitable for learning. Teacher questionnaires revealed that interactive problem-based learning media had an average practicality of 98% (81%≤X≤100%), indicating "Very Practical." The researcher's interactive problem-based learning media was 87.21% practical according to the student response questionnaire. According to practicality rating rules, a score of 80% ≤ X ≤ 100% indicates "Very Practical" status. The generated interactive media can be used in future MAN 1 Medan lessons. The results of improving students' mathematical concept understanding showed that interactive problem-based learning media increased each indicator calculated based on students' pretest and posttest scores: 1) The indicator of restating a concept increased by 29.2%, from 55.3% to 84.5%; 2) The indicator of using, utilizing, and selecting certain concepts also showed improvement. Additionally, pupils' mathematics understanding improved with an average N-Gain score of 0.70 (range: 0.30 ≤ n < 0.70), indicating a "moderate" increase. At MAN 1 Medan, interactive media focused on problem-based learning has improved students' mathematical comprehension.

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