Interactive Multimedia with Problem-Based Learning in Mathematics

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A R T I C L E I N F O

A B S T R A K

Mengingat materi matematika mempunyai peranan penting dalam kehidupan sehari-hari, maka media pembelajaran dalam pembelajaran memerlukan media pembelajaran untuk menyajikan materi pembelajaran yang bersifat abstrak menjadi konkrit. Multimedia interaktif dapat meningkatkan hasil belajar siswa pada mata pelajaran matematika. Selain itu model pembelajaran PBL mampu mendorong siswa untuk belajar secara aktif dalam memecahkan suatu masalah. Oleh karena itu penelitian ini bertujuan untuk mengembangkan multimedia interaktif berbasis masalah pada pembelajaran matematika untuk siswa kelas VII SMP. Jenis penelitian ini adalah penelitian pengembangan dengan model ADDIE yang mencakup lima tahapan sistematis di dalamnya. Data yang dikumpulkan adalah data kuantitatif dan data kualitatif dengan menggunakan 3 metode pengumpulan data yaitu wawancara, angket, tes objektif. Tahapan model ADDIE yang terdiri dari lima tahap yaitu tahap analisis, desain, pengembangan, implementasi dan evaluasi. Hasil penelitian ini menunjukkan bahwa multimedia pembelajaran interaktif berbasis masalah valid dengan kualifikasi sangat baik. Selain itu pembelajaran multimedia interaktif dengan pembelajaran berbasis masalah efektif digunakan pada pembelajaran materi himpunan matematika kelas VII di SMP.

A B S T R A C T

Considering that mathematics material has an important role in everyday life, learning media in learning requires learning media to present learning material that is abstract to become concrete. Interactive multimedia can increase student learning outcomes in mathematics. Apart from that, the PBL learning model is able to encourage students to learn actively in solving a problem. Therefore this research aims to develop interactive multimedia with problems based on learning in mathematics for class VII students of junior high school. This type of research is development research with the ADDIE model which includes five systematic stages in it. The data collected are quantitative data and qualitative data using 3 data collection methods, namely interviews, questionnaires, objective tests. The stages of the ADDIE model which consists of five stages, namely the stages of analysis, design, development, implementation and evaluation. The results of this study indicate that problem-based interactive multimedia learning is valid with very good qualifications. Moreover multimedia interactive learning with problem-based learning was effectively used in learning class VII mathematics set material at junior high school.

1. INTRODUCTION

Education is an effort to develop a quality of human resources in a directed and comprehensive manner by all generations of the nation so that they can develop optimally with the support of various parties. The field of education plays a very important role because it functions to prepare generations who will work and lead Indonesia and through the field of education Indonesia will also be able to compete in the international world (Fırat & Laramee, 2018; Komariah et al., 2018). The field of education plays a very important role because it functions to prepare generations who willwork and lead the Indonesian state, and through the field of education Indonesia will also be able to compete in the international world. Therefore, education in its development should be in line with changes in life, seeing the current developments in science and technology which are developing very rapidly (Lampropoulos et al., 2019; Ng, 2019). The rapid progress of the development of technology has affected all areas of life, including the field of education. Seeing this reality, where technology and information have become an important part of life, it is necessary to have generations of nations or human resources who have competitive, adaptive and independent abilities in supporting development and dealing with changing situations and conditions. With the existence of such human resources, peaceful, prosperous and reckoned lives in the world community will be achieved. To anticipate this, the national education system must be able to support development in the future (Kupers et al., 2019; Taylor et al., 2015). According to previous study education that is able to support future development is education that is able to develop students' potential, so that students are able to face and

solve life's problems they face. Students are an important component in an education (Komariah et al., 2018). At the elementary and secondary levels, mathematics is included as a basis that students must master. Because of the importance of mathematics at the primary and secondary education levels, the subject of mathematics ranks first in terms of the number of hours of study. This shows the importance of mathematics lessons for students to learn.

Mathematics is a discipline that is taught at various levels of education to students. According to previous study mathematics is one of the scientific disciplines that can improve the ability to think and argue, contribute to solving everyday problems in the world of work, and provide support in the development of science and technology (Janah et al., 2019). Besides that, mathematics is a branch of science that plays an important role in human life and forms the basis for other sciences. Therefore, to study mathematics, it is necessary to understand the concepts contained in mathematics, develop clear, precise and thorough thoughts. In learning mathematics certainly requires a mindset, reasoning and logic (Arsisari et al., 2021; Wedayanti & Wiarta, 2022). So that in the learning process, students must be accustomed to gaining an understanding through experience of the properties of a set of objects (abstraction). However, most students still think that mathematics is an abstract science and difficult to understand. According to previous study basically learning mathematics has abstract characteristics and uses a language of symbols that is difficult for students to understand because the development of their thinking is at the concrete operational stage which causes students to not be able to think abstractly (Wedayanti & Wiarta, 2022). Therefore, in learning mathematics learning media is needed to visualize the mathematics learning material.

But in reality, the use of learning media is an obstacle for teachers, due to the teacher's lack of knowledge of technology and the teacher's lack of skills in making learning media, according to the material to be delivered. Based on the results of interviews conducted with a mathematics teacher at Singaraja 6 Public Middle School, it was discovered that the media used is usually in the form of videos, but for math lessons more often explained directly using the lecture method on the blackboard rather than using the media. Base on observation the average daily test results are still below the standard value of the Maximum Completeness Criteria (KKM) with an average daily test score on set material of 26.53 with a Minimum Completeness Criteria value of 70. This indicates that there are problems in the implementation of learning in less effective classes so that students' mastery of set material in mathematics is still lagging behind. According to previous study one of the problems facing the world of education today is the weak implementation of the learning process, where students are only directed at the ability to memorize various information without students' active involvement in it in learning (Permana & Nourmavita, 2017).

From the statement above, the learning that is carried out often uses the lecture method which makes students more passive and the learning process is less interesting and boring. Even though in learning, of course, the active involvement of students is very necessary and important to increase students' understanding of the material presented by the teacher (Astuti et al., 2020; Sutarto et al., 2020). Considering that mathematics material has an important role in everyday life, learning media in learning requires learning media to present learning material that is abstract to become concrete. To create pleasant learning conditions and students are more motivated in learning mathematics so that student learning outcomes are better. In this case, the use of learning media is also closely related to improving the quality of education (Al Shammari, 2021; Liliawati et al., 2018). The use of media by the teacher in the learning process is expected to create a more meaningful learning atmosphere and learning experience, and enrich student learning experiences. Thus the learning atmosphere that used to be passive and boring can turn into fun and interactive.

Learning that focuses on problems and looking for solutions to solve problems can train students' critical thinking skills. Thus, one way that teachers can do in learning mathematics is to apply the Problem Based Learning model in the learning process. The PBL learning model is a learning model that provides authentic experiences that encourage students to learn actively, where in practice students are directly involved in solving a problem so as to be able to encourage students to think critically which can later train students to solve a problem independently (Juliawan et al., 2017; Priani et al., 2019; Rahmadani & Taufina, 2020). Therefore, interactive multimedia with problem-based learning methods is needed to help real mathematics and teacher learning in conveying set material. This media can involve students actively in learning so as to increase motivation, interest in student learning, in increasing learning outcomes. Like the research conducted by previous study applying interactive multimedia-based mathematics learning media at Annur Prima Islamic Private Middle School, the results of the study show that interactive multimedia-based mathematics learning media shows that there is an increase in student learning outcomes after using the media (Arriza, 2020). Likewise with research conducted by other study with research on the development of problem-based learning interactive mathematics learning media in Class V SDN 22 Duku, Koto XI Tarusan District, showing an increase in student learning outcomes after using the media (Sari et al., 2021).

Thus, one of the efforts to overcome the problems that occur in Singaraja 6 Public Middle School is to use innovative learning media, namely interactive multimedia in mathematics subjects in set material with its presentation combined with problem based learning syntax which is able to attract students' attention in learning.

Based on the description above, the writer is interested in conducting research with aims to develop interactive multimedia with problems based on learning in mathematics for class VII students of junior high school.

2. METHOD

This study is using the Research and Development (R&D) method. In conducting this research, one of the models or approaches to designing a learning system is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The ADDIE model was developed systematically and is guided by the theoretical foundation of learning design (Tegeh & Kirna, 2013). The ADDIE model consists of five stages, namely the analysis stage , the design stage , the development stage , the implementation stage , and the evaluation stage. The test subjects in this study consisted of experts namely one content expert, one designer expert, and one media expert who assessed the products being assessed (Dasi & Putra, 2022; Dwiqi et al., 2020), then there were 3 students as individual test subjectsand 9 students as small groups. Data collection methods used in this research are instruments and tests. The instruments used to collect data in this interactive multimedia development research can be seen in Table 1, Table 2, Table 3, and Table 4.

Table 1. Study the Content Expert Grid

No	Aspect	Indicator	No. Grain	Number of Items
1	Curriculum	Multimedia suitability, indicators, and learning objectives.	1, 2, 3	3
2	Method	Clarity and presentation of complete materials, examples, pictures, and animations.	4, 5, 6 , 7	4
3	Language	The use of clear and precise language and sentences in accordance with communication with students.	8 , 9	2
4	Evaluation	The level of difficulty of the questions, the suitability of the questions with the learning objectives, and the questions given are easy to understand.	10 , 11 , 12	3
		Amount		**12**

Table 2 . Learning Design Expert Grid

No	Aspect	Indicator	No. Grain	Number of Items
1	Objective	Clarity of learning objectives	1, 2, 3 , 4	4
2	Strategy	Learning activities that can motivate students,	5, 6 , 7	3
3	Material	Submission of material provides logical steps, delivery of interesting material, clarity of steps for using the media	8 , 9, 10	3
4	Evaluation	Submission of material on the media, evaluation to measure students' abilities	11 , 12	2
		Amount		**12**

Table 3 . Learning Media Expert Grid

No	Aspect	Indicator	No. Grain	Number of Items
1	Text	Text clarity (text readability), text presentation, size and type of text.	1, 2, 3, 4	4
2	Picture	Image layout, quality, color balance and image attractiveness.	5, 6, 7	3
3	Animation	The quality, attractiveness, and suitability of the animation with the material presented.	8 , 9	2
4	Audio	Clarity and suitability of the use of voice / sound music and narrator.	10 , 11	2
5	Packaging	The attractiveness and suitability of the CD cover to the media content.	12 , 13	2
6	Accessibility	Ease of access or use of learning multimedia and smooth interactive relationships	14 , 15	2
		Amount		**15**

Table 4 . Individual and Small Group Pilot Grids

No	Aspect	Indicator	No. Grain	Number of Items
1	Attraction Aspect	Ease of use , attractiveness and accuracy of presentation of text, images, animation, language and sound. Ease, interest and motivation in learning. Evaluation	1, 2, 3, 4 5,6,7,8,9,10, 11,12,13,14, 15	15
		Amount		**15**

This development research uses 3 data analysis techniques, namely descriptive qualitative analysis, quantitative descriptive analysis, and inferential statistical analysis. A qualitative descriptive analysis is research that aims to describe the phenomena that occur in the research subjects in depth. Descriptive research is intended to get an overview and information regarding learning media, student characteristics, methods, strategies and the mathematical material being studied (Sakiah & Effendi, 2021). The resulting data is in the form of a description in the form of narrative text, which is an outline description of the data that has been collected.

Quantitative descriptive data analysis method is a method of systematic data processing in the form of sentences so as to obtain general conclusions. This analysis technique is used toprocess the data obtained through a questionnaire in the form of a descriptive percentage. The formula used to calculate the percentage of each subject is. to calculate the percentage of all subjects used the formula and to be able to provide meaning and decision making used the information in Table 5.

Table 5 . Convert the Level of Achievement with a Scale of 5

Achievement rate %	Qualification	Information
90 – 100	Very good	No need to revise
75 – 89	Good	Slightly revised
65 – 74	Enough	Revised to taste
55 – 64	Not enough	Many things were revised
0 – 54	Very less	Repetitive product creation

Inferential statistical analysis is statistics used for analyze sample data and the results will be generalized and inferenced to the population where the sample was taken. This inferential statistical analysis is used to determine the level of product effectiveness on student learning outcomes. Hypothesis testing is done by correlation t-test analysis. The trial results were compared to t tables with a significance level of 0.05 (5%) to determine the effectiveness of interactive multimedia products (Wicaksana et al., 2020; Widiana, 2016).

3. RESULT AND DISCUSSION

Result

In conducting this research, one of the models or approaches to designing a learning system is the ADDIE model. The ADDIE model was developed systematically and is guided by the theoretical foundation of learning design. The ADDIE model consists of five stages, namely the analysis stage, the designstage, the development stage, the implementation stage, and the evaluation stage. The advantage of the ADDIE model is that it can minimize errors and deficiencies from the beginning of the product that will be produced at the final stage because of the evaluation at each stage. In terms of development research procedures ADDIE revealed that there were several research steps as follows: 1. Analysis, 2. Design, 3. Development, 4. Implementation, and 5. Evaluation. At the analysis stage, the thing to do is to analyze the needs and problems in the form of relevant materials, textbooks, and learning conditions. As for what is done from each stage in the ADDIE development model. The analysis phase is the initial stage carried out by researchers to identify existing problems through observation. The purpose of the analysis is to analyze needs and collect information about students as a basis for designing before making a product. In the analysis stage, the activities carried out are observation and interviews, analysis of student characteristics, analysisof problems that arise in the learning process, analysis of the learning system and materials used as well as analysisof the environmental situation and supporting facilities at school. The analysis carried out aims to obtain all the information and data that will later be used to make decisions and considerations before developing interactive multimedia products according to the needs of students at SMP Negeri 6 Singaraja.

Design phase, the next step after completion of the analysis phase. The design stage aims to design or design learning multimedia products that will be developed. Of course, this design also refers to thecurriculum, syllabus, lesson plan, both in terms of material, language, and design that will be implemented in thislearning multimedia.

Continuing the development stage, the activities carried out make the product adapted to the storyboard and flowchart that has been previously designed. As well as enriching the design of animation design assets, images and illustrations needed.

After development, then implementation, in the process of developing this interactive multimedia product, all components that have been made are put together using articulate storyline 3 and supported by other applications. Then it becomes one unit in interactive multimedia with problem based learning which is named the "Ruangta" application. Interactive multimedia with problem based learning is teaching material in the form of learning media containing text, images, animation, sound, music and quizzes whose presentation is combined with problem based learning syntax. In addition, in implementing interactive learning multimedia with problem based learning in the learning process on set material in class VII at Singaraja 6 Public Middle School was able to increase student enthusiasm and motivation in learning enthusiasm. The use of media attracts student learning motivation , of course, because interactive multimedia is developed according to the syntax of the problem based learning method.

The last, entering the final stage namely the evaluation stage that will be passed in this development process. This evaluation phase aims to assess the quality of the product and the teaching process, both before and after the implementation phase. Improvement of interactive multimedia-based mathematics learning media was carried out based on teacher and student responses during implementation. The essence of this evaluation is to ensure that the media developed is relatively perfect when used in actual learning situations. The results of the data analysis obtained from the product feasibility test can be seen in Table 6.

Table 6 . Results Percentage Validity Interactive Multimedia Development

No.	Trial Subjects	Percentage (%)	Information
1.	Learning Content Expert Test	92	Very good
2.	Learning Design Expert Test	92	Very good
3.	Learning Media Expert Test	95	Very good
4.	Individual Trial	95.56	Very good
5.	Small Group Trial	89.49	Good

Based on the percentage of validity results from the five tests, the developed interactive multimedia is feasible and gets a very good percentage so that it can be concluded that overall the validation results for the development of interactive multimedia are feasible to use. in learning activities. The following results of problem based learning interactive multimedia development can be seen in Figure 1.

Figure 1. Display Main Page

If seen in table above, the results of research with the development of problem-based interactive multimedia while learning in mathematics get a very good average qualification after being tested on students and experts. Based on the results of the learning content expert test is regarding the suitability of the material with the formulation of basic competencies, learning objectives, learning indicators, and easy-to-understand language. In the content of learning material on interactive multimedia questions based on learning is feasible because the teaching materials contained in the developed media fulfill these three things.

Discussion

Learning materials must be relevant to achieving competency standards and achieving basic competencies. If the ability that is expected to be mastered by students is in the form of memorizing facts, then the learning material taught must be in the form of facts, not concepts or principles or other types of material (Hidayat & Nizar,

2021; Wedayanti & Wiarta, 2022). According to previous study in formulating learning objectives the teacher must fulfill the ABCD elements, namely audiences, behavior, conditions and degrees (Yanti, 2019). Cleargoals are very helpful for teachers in determining and adjusting learning materials. the suitability of the material with the learning objectives, namely the material according to the learning indicators, there is no material that deviates, and the material is in accordance with the student's level of ability. This opinion is in accordance with opinion which states that the main thing in the development of the media to be used is the suitability of the material with the goals to be achieved (Hasanah & Nulhakim, 2015). In the linguistic aspect, the language used is easy to understand because the use of language in presenting the material is in accordance with the characteristics of the students. According to previous study language is the most effective communication tool for conveying ideas, thoughts, aims and objectives to others and makes it possible to create cooperation between people (Mailani et al., 2022).

The results of the learning design expert test regarding the use of media attract students' learning motivation Of course, because the developed interactive multimedia is in accordance with the problem-based syntax while learning methods. The use of media can attract students' learning motivation of course, because the interactive multimedia that is developed is in accordance with the syntax of the problem-based learning method (Kartiko et al., 2022; Kurnia et al., 2019). Learning by using the problem approach based learning (PBL) can significantly increase student learning motivation, as well as conventional approaches that can significantly increase student learning motivation (Arief et al., 2016; Huang et al., 2020). The approach at the beginning of the learning material contained in the media uses problems basedon learning approaches by associating questions according to problems that exist in students' daily lives. So that students will feel the benefits of learning mathematics and students will gain new knowledge that is more real. According to previous study the problems raised in this teaching and learning activity have various kinds of answers that are open-ended, this is so that students can think openly about all existing problems, be actively involved in investigating a problem (Al Shammari, 2021). This is ableto make students feel happy and there is no coercion from others, he tries to find resources independently that canbe used to continue learning . In learning multimedia products, the image illustrations used in the media are in accordance with the learning material. According to other study visual illustrations have a very strategic rolein learning because they are a simple, effective and efficient form of visual communication (Ozdamli & Ozdal, 2018).

The results of the media expert's test regarding the text on the media are appropriate because the size and type of text are appropriate, of course because the body text size and title text size are used differently. The body text contains information on the title of the material or topic to be discussed so that the size is made larger than the size for the title text containing the material so that the size and type are appropriate and the selection of fonts is so easy to read because the selection of typography in this interactive multimedia uses the Comic Sans MS font. According to previous study Comic sans font type is simple and clear so it is easy to read when used by students and teachers (Lukman et al., 2019). Images presented in the media look attractive because the use of images provides a clearer illustration of learning material to students, according to illustration pictures are teaching tools that can attract students' learning interest effectively (Sundari, 2016).

The animation used is in accordance with the material presented because the animation used is in accordance with the media and interactive learning materials. According to previous study said that learning materials will look attractive because they can be made in various colors and can be made in animated versions (Janah et al., 2022). Therefore, in conveying learning material so that it can be well understood by students, the accuracy of the imagesused as well as the right and harmonious composition and color combinations will be able to motivate student learning. For the use of music used in accordance with the media, of course, because the music used is in the formof instrumental. Using instrumental music can be a motivator for children when studying, because music can makelearning passionate and release tension in completing activities (Colwell, 2013; Syamsuardi et al., 2022).

The development of interactive multimedia with problem based learning is effectively used in mathematics for class VII junior high school students. The effectiveness of the development of interactive multimedia with problem based learning was carried out by giving multiple choice question sheets to 34 class VII students at SMP Negeri 6 Singaraja, through tests. The pre-test is carried out before students learn to use interactive multimedia with problem based learning while the post-test is carried out after students learn to use interactive multimedia with problem based learning. Then from the test results, a t-test was carried out for correlated samples. The average student pre-test result was 33.38 and for the post-test an average score of 86.62 was above the National KKM score for mathematics at 75. The increase in the average student score can be seen based on student answers when answering test. Most of the students' answers that were wrong during the pre-test became correct during the post-test. This is of course due to the use of interactive multimedia with problem based learning when the learning process students are more enthusiastic and interested in learning. Thus it can be concluded that the use of interactive multimedia with problem based learning in mathematics for class VII students at SMP Negeri 6 Singaraja is effective in improving student learning outcomes.

4. CONCLUSION

The development model used in this development process is the ADDIE model which consists of five stages, namely 1) Analysis Stage, 2) Design Stage, 3) Development Stage, 4) Implementation Stage, and 5) Evaluation Stage. In this model, every stage in multimedia development plays an important role in producing a good product. Therefore, a series of trials were conducted to determine the feasibility of using interactive multimedia. Several stages were carried out in the trial, namely, 1) review by learning content experts, 2) Review of learning media experts, 3) Review of learning design experts, 4) Individual trials, 5) Group trials, and 6) Field trials. The results of the validity of problem-based interactive multimedia learning were obtain very good qualifications. The results of testing the effectiveness of problem-based interactive multimedia learning are effectively used in learning mathematics for class VII set materials at SMP Negeri 6 Singaraja.

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