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DEVELOPMENT OF DIGITAL BOOK STEM WITH DESIGN THINKING ASSISTED BY AUGMENTED REALITY IN IMPROVING MATHEMATICAL LITERACY ABILITIES

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ABSTRACT

This study aims to develop digital book learning media based on STEM with a Design Thinking approach and assisted by Augmented Reality (AR) to improve students' mathematical literacy skills. Media development was carried out using the ASSURE model consisting of six stages: (1) Analyze Learners, analyzing the characteristics of class VIII students of MTsN 3 Grobogan; (2) State Objectives, formulating learning objectives that integrate mathematical literacy and the STEM approach; (3) Select Methods, Media, and Materials, choosing PJBL strategies, AR technology, and curriculum-based materials; (4) Utilize Media and Materials, developing and implementing interactive digital books in learning; (5) Require Learner Participation, encouraging active student involvement through project completion and exploration of AR features; and (6) Evaluate and Revise, conducting trials, evaluating media effectiveness, and revisions based on student and validator input. The subjects of the study were class VIII students of MTsN 3 Grobogan. Data collection was carried out through pretest-posttest, student response questionnaires, and expert validation. The trial results show that this interactive digital book media is effective in improving students' mathematical literacy skills, interesting to use, and encourages students' active involvement in project-based and technology-based learning. Thus, this media is worthy of being used as an innovative alternative in mathematics learning.
Keywords: Literasi Matematika, Design Thinking, Augmented Reality, Digital Book

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PRELIMINARY

Reforms in the world of education are something that must be done so that the education system in Indonesia continues to develop and be of high quality, especially in the subject of mathematics (Rahmawati, 2023). To answer the demands of developments and needs in the field of education, the Indonesian Government through the Ministry of Education and Culture has implemented various innovations, including in terms of curriculum evaluation and renewal (Kemendikbudristek, 2021). This is marked by the implementation of the Independent Curriculum, known as the Revised 2013 Curriculum. (Khadijah,2023). Mathematics has a very vital role in the field of education, which can be

seen from its contribution in supporting the development of students, meeting the needs of society, and preparing individuals for challenges in the world of work (Alawiyah, 2017). Mathematics lessons in schools are not only aimed at honing students' calculation skills, but also at strengthening their logical and critical thinking skills when they experience problems in everyday life. (Kusumawardani et al., 2018).

Based on the results of the PISA study, mathematical literacy questions emphasize critical thinking skills and problem solving that are oriented towards many situations and challenges encountered in everyday life (Astuti, 2018). The skills assessed in PISA are classified into several series elements, namely problem solving skills, reasoning skills, and communication skills (Taneo 2015). The mathematical literacy skills of students in Indonesia are quite low as seen from the results of the PISA survey in 2017. The PISA test is an international study on achievement in reading, mathematics and science (Azmi 2020). PISA has six levels of ability that show the average score of students worldwide in mathematical literacy. Based on the results of the Program for International Student Assessment (PISA) in 2022, it was stated that the problem-solving skills of Indonesian students need to be improved because they showed a decline of 12-13 points compared to 2018 and what is worrying is that only 18% of Indonesian students have obtained minimal mathematical skills (OECD, 2023).

Behind all that, there are things that cause why students' mathematical literacy is still minimal. The use of teaching materials that can replace conventional books is very necessary to support mathematical literacy skills. Subject matter is one of the obstacles in inhibiting the ability to understand mathematics experienced by students (Romadhani,2022). One of the factors causing students' lack of understanding of mathematics is the use of learning materials and media (Taneo, 2015). Based on the description, it is mandatory to carry out innovation procurement to raise literacy skills in students. Efforts to improve mathematical literacy have many mechanisms that can be used to raise the increase in students' mathematical literacy (Ramadhan, 2023).

Digital student books, also called “digital textbooks,” can serve as a source of motivation for students with the goal of improving their mathematical literacy (Purba,2023). With the progress of time and supported by technological innovation, various kinds of learning resources have emerged that can be used in the education process, one of which is digital books, also known as digital books (Farhana,2021) The use of digital books can improve students' mathematical literacy, which can lead to interactive learning (Purba ,2023) The use of digital books can make things easier for students,

because by just bringing a device, students can read books wherever and whenever they want (Sugianto, 2017)**..** The use of digital books can improve the relationship between students and teachers during distance learning (Haslinda,2022). Students feel helped in terms of storage space, costs for repairing books, and studying remotely after the availability of digital books was felt by the students themselves (Nuzulia, 1967),

Based on the researcher's observations at Mts Negeri 3 Grobogan, it was found that the factors causing low mathematical literacy skills were the students' inability in terms of knowledge, which resulted in a lack of accuracy from the students when working on questions (Wulandari, 2023). Researchers also obtained information from related teachers that the type of error most often made by students is an error in understanding questions. Related to the above problems, there are various alternatives that can be used to overcome them, such as the use of technology in creating learning media, nowadays there are many software that can be used to create interesting learning media, including learning media based on Augmented Reality (Sulasmianti, 2018). Augmented Reality is a visual media that can be displayed in the real world via a camera device, so that abstract objects can appear more real (Balandin et al., 2010). Augmented Reality software is a 21st century technology that can combine two virtual objects with the real environment. The use of Augmented Reality-based learning media can improve the learning process and increase students' interest in learning. This is due to the attractive design in AR, which can strengthen students' interest in learning and playing, and show it in real terms and invite all students' senses from the eyes, ears, and skin of students to use AR technology. (Mustaqim.,2016) ini sama dengan (Lee , 2012) Augmented Reality can improve the learning atmosphere to be effective, fun, and involve students. Using Augmented Reality (AR) technology, an object that previously could only be observed in 2 dimensions can now be displayed as a virtual object inserted into a real environment in real time (Dian, 2019).

Material on flat-sided geometric shapes such as cubes, blocks, prisms and pyramids is a topic in mathematics learning. (Pratiwi, 2018). This material will be presented in digital format and will be taught using the PjBL STEM approach to help students at MTs Negeri 3 Grobogan improve their mathematical literacy (Dirgantara, 2023). Project Based Learning, also known as PjBL, is a methodology that can be used to provide insight to students because it is based on products produced throughout the teaching process (Pea Yuanita Meishanti, 2020). Project-based learning is a learning model where the center is on the student and students can experience a meaningful learning experience for them

(Yuniarti, 2021). Therefore, students can have the resources and abilities to contribute and implement innovative and creative ideas by researching everything new through the projects they are working on (Isnaniah, 2017). In addition, PjBL should be used in conjunction with appropriate fields of study, such as science, technology, engineering, and mathematics, or STEM for short (Pane, 2024).

This is in line with Wayong's 2017 research on mathematical literacy, which found that only one of the three research subjects was able to work on the questions correctly, indicating differences in conceptual understanding and mathematical literacy skills in all students. Ukima's research (2023) Related to the use of digital books with the PJBL STEM curriculum to improve geogebra mathematical literacy, students' mathematical literacy is still low due to the lack of skills needed in the classroom. Based on this, researchers developed educational media in the form of digital books with PjBL-STEM content created using the Geogebra application with the aim of increasing students' mathematical literacy in the material of flat-sided spatial figures. The purpose of this study is to evaluate the effectiveness of the use of digital books in improving students' mathematical literacy (Ukima, 2023).

METHODS

The method used in this study is research and development or Research and Development (R&D) (Waruwu, 2024). In this study, the product developed is a digital book with a PjBL STEM approach based on design thinking to improve the mathematical literacy skills of eighth grade junior high school students in the material on Flat-sided Space Buildings using the ASSURE development model (Rosdiana, 2022).

Figure 1 ASSURE Stages

The Analyze Learners stage is the stage of collecting information that the author wants to create as a basis for creating interactive media in the form of a digital book based on PJBL-STEM assisted by Augmented Reality. Namely, an electronic book that not only contains text and images, but is also equipped with interactive elements such as videos, quizzes, animations, and Augmented Reality (AR) with a learning approach that emphasizes student involvement in real projects to solve problems integrated with Science, Technology, Engineering, and Mathematics in the learning process and Augmented Reality (AR) Technology that combines the real world with digital objects (3D, animation, video) that can be viewed through devices such as smartphones/tablets (Pasien 2024). The author conducted a needs analysis using an interview mechanism with teachers and students at MTsN 3 Grobogan. The interview was conducted to analyze facts and problems in the field.

In the state objective stage, the author considers media ownership, technology, and strategy. At this stage, the author identifies the steps to be taken to create a media design that can improve educational media (Ibrahim, 2024). At the Select Methods, Media and Materials stage, after obtaining data from the observation results, the next step is for the researcher to determine the design of the learning media, including the creation of media design with everything in the form of making questions, materials, and answers, creating backgrounds, fonts, images, buttons and animations to be used in the application and compiling research instruments.

At the utilize media material stage, namely the design validation stage, the test is carried out by carrying out a media assessment by experts, namely material and media experts. The results of the expert assessment will determine the feasibility of the media when tested on users. After the media is validated by experts and material experts. The next stage is to make improvements and revisions to the media based on suggestions from experts. If the media has met the criteria and no further improvements are needed, then the media is ready to be tested on users or students. Preparation for the Media Trial aims to determine the effectiveness, attractiveness, and understandability of the interactive media that has been developed. Trial Subjects Grade VIII students at MTs Negeri 3 Grobogan. The type of product developed is an interactive digital book based on PJBL-STEM with Augmented Reality features. Implementation of the Trial in the classroom using AR supporting devices such as tablets/smartphones. Purposive Sampling Sampling Technique (Purposive Sampling) is the deliberate selection of samples based on certain criteria. Sample selection criteria: Grade VIII students who have studied material relevant to the

content of the digital book. Have basic skills in using digital devices (tablets/smartphones). Considered representative by subject teachers or researchers. Reasons for Selection The media tested are specific (based on PJBL-STEM with AR features), so that only students who meet certain criteria are relevant to be involved. The goal is to measure the effectiveness of the media more precisely, not for broad generalization. Trial Activities, namely Students are given directions on how to use interactive digital books and their AR features. Students study the material through the media that has been provided in the form of STEM-based projects. Interacting directly with AR Students scan markers or images that display 3D objects next Discussion and completion of the project According to the principles of PJBL, students complete project assignments while exploring the media.

After the learning media has been validated and revised, the media is ready to be tested. The test was conducted on class VIII students of MTsN 3 Grobogan. Student responses were analyzed through a questionnaire. The second stage of revision was carried out if there was criticism of input from students as the subject of the product trial. After carrying out improvements based on input and suggestions from validators and users, the final product was created. The product in this study is in the form of an interactive digital book media based on PJBL-STEM assisted by Augmenten Reality. The collection technique used was the distribution of a Likert scale questionnaire with 5 answer choices. The scoring used in the validation assessment can be seen in table 1

Table1. Expert Validation Sheet Assessment Score

Score	Eligibility Answer Choices
5	STRONGLY AGREE
4	AGREE
3	UNSECURIOUS
2	DISAGREE
1	STRONGLY DISAGREE

At the same time, Table 2 presents the results of the product practicality test.

Table 2. Trial assessment scores

Score	Eligibility Answer Choices
5	Very Interesting
4	Interesting
3	Quite
2	Not Interesting
1	Very Not Interesting

Qualitative data obtained are first transformed based on the weight of the scores into quantitative data. The percentage is calculated using the formula:

$$Percentage \frac{number\ of\ scores\ obtained}{maximum\ score} x100\%$$

Eligibility categories are based on the following results:

Table 3. Media Eligibility Criteria

No	Score (%)	Eligibility Category
1	81%-100%	Strongly Agree
2	61% - 100%	Agree
3	41%- 60%	Quite
4	21%-40%	Not Interesting
5	< 21%	Very Not interesting

RESULT AND DISCUSSION

The results of the development are interactive digital books based on PJBL-STEM that can be installed on smartphones and use augmented reality. Below are the results of the development of Android-based media based on completed tasks:

1. Analyze Learners Stage

   Observation and interviews with mathematics teachers at MTs N 3 Grobogan are things that the author carried out. Based on the results of research and observation, there are many learning media used in classroom learning, causing students to become bored and reducing their mathematical literacy. Therefore, solutions and learning media are needed to improve the quality of education in schools and students' mathematical literacy (Sadewo, 2023). This problem can be overcome by having a STEM-based digital book assisted by Augmented Reality (Bahru., 2023). Digital books that replace traditional books with the PJBL-STEM approach are contextual learning media that help students understand phenomena in everyday life so that they can increase students' interest in learning flat shapes (Nikmaturrobby & Nurbaiti, 2024).

   The analysis carried out on students includes the main points, namely: (1) general characteristics of students, where researchers understand and confirm the general characteristics of students and note any discrepancies in the use of learning media which mostly use conventional methods (2) Student abilities The author gave tests to students to understand the level of mathematical literacy and collected data that showed that students' mathematical literacy skills were still lacking. (3) The researcher's analysis of the differences in student needs showed these differences. Flat side space is used as teaching materials. The use of STEM-based digital books assisted by Augmented Reality in implementing learning can improve students' mathematical literacy skills (Rebecca et al., 2024).

2. ***State Standards And Objective***

   The author conducted a standardization study and the intention of creating a digital book that creates a valid and practical product. STEM-based digital books based on Augmented Reality are expected to be used to facilitate learning activities carried out in schools. To solve the problem of building a side data space, the researcher uses augmented reality software (Setyawan et al., 2020). The author also uses Canva software to make digital books have the appearance of conventional books which are practical because they are on students' gadgets (Yulianti & Herman, 2023).

3. ***Select Strategies and Resources***

   The researchers clarified the educational approach that ultimately resulted in the STEM-based digital textbook with augmented reality support. The digital textbook given to the students also included several test tools used to evaluate the study being conducted. At this stage, the authors provide examples of tests that function as pretests and posttests and are used to assess students' mathematical literacy. In addition, the researchers provide information to the students about the STEM-based digital textbook that uses augmented reality in the classroom. (Pane et al., 2024).

4. ***Utilize Resources***

   The researcher validated the explanation of the material and media to a validator who is an expert in his field. The test was carried out by carrying out an assessment of the design of the learning media which was carried out by expert development, namely material and media experts. The material expert who became the validator in this study was a mathematics teacher who had good abilities, generally in terms of professional abilities. In the results of the validation carried out, there were a few suggestions regarding the explanation of the material issued using simple language adjusted to the age of the students and in the form of HOTS questions. Then the validation carried out by the media expert looked more at the appearance of the background so that it was created simply so as not to hinder student focus when using the learning media created.

   The material test was carried out by mathematics teachers. The instrument was in the form of a questionnaire with a Likert scale with a value range of 1 to 5. The number of statement items was around 20 items. Consisting of general aspects, material and language.

Table 4. Material Test Results

NO	Assessment Aspect	Maximum score	Observation Score	Eligibility
1	General	25	25	100%
2	Materials	55	51	92%
3	Languange	20	19	95%
Total score		100	95	95%

The overall score of the material expert's eligibility is around 95 out of a maximum score of 100, or 95%. Based on the Likert scale, the total score is in the very feasible category. The interactive learning media test by media experts was carried out by lecturers who are learning media experts who specialize in programming and Android-based applications. The instrument in the form of a questionnaire uses a Likert Scale with a value range of 1-5. The number of statement items is around 20 indicators tested, covering general aspects, materials, media, and language

Table 5. Media Test Results

NO	Assessment Aspect	Maximum Score	Observation Score	Eligibility
1	General	25	25	100%
2	Materials	20	20	100%
3	Media	35	30	85%
4	Laguange	20	18	90%
Score total		100	93	93%

The total of the media expert's eligibility score is 93 out of a maximum score of 100, or 93%, based on the Likert criteria total score in the very feasible category. The input given is that the appearance is good, but the cover is not yet visible and is suitable for use with a few revisions.

5. ***Require Learner Participation***

At this stage, the initial research conducted a trial in the experimental class and the control class. The trial in this study was class IX B which had obtained building materials for the flat side. The trial questions were conducted to determine the validity, reliability, level of difficulty and distinguishing power. After that, the researcher analyzed the trial questions to find out which questions were valid and suitable for use in the experimental class and the control class. Based on the results of the analysis of the trial questions, 2 essay questions were obtained as valid questions. Through the calculation of the reliability of the questions, the results showed that the trial was reliable in the high category. Of the 5 questions, there were 5 questions with a moderate level of difficulty. Next, the distinguishing power of the 5 questions was 3 questions that were not good. Overall, from the results of the analysis, there were 2

questions worthy of use in the study from 5 instrument questions. Furthermore, the researcher applied learning media to the experimental class. Class VIII was made as an experimental class. Before the learning media was implemented in the experimental class, the author carried out the first data analysis which was carried out in order to understand what the control class and the experimental class came from a normally distributed population.

6. Evaluation And Revise

The data analyzed were the pretest scores of two classes: the experimental class and the control class. The pretest was conducted before the treatment to determine whether the students' initial abilities were equal and the data met the requirements for parametric statistical analysis. Purpose of Analysis To determine whether the pretest data is normally distributed. Why is it important? Because parametric statistical tests (such as the t-test) require normally distributed data. The Liliefors test is used to test the normality of data distribution, especially for small samples (n <50). In this test, we compare the L-calculated value (the result of the calculation from the actual data) with L-table (critical value) taken from the Liliefors table based on the number of samples (n) and the level of significance (α). Normality Test Results.

Table 6. Normality Test

Class	n	L_{Hitung}	L_{Tabel}	Conclusion
Experimen	30	0,1018	0,161	Normally Distributed
Control	30	0,1459	0,161	Normally Distributed

Based on the table above, the price in the experimental class is 0.1018 for n = 30 with a significance level of 5%, the price based on the Lilieford test critical value table is 0.161. This shows that it is 0.161, so it is accepted. Based on these calculations, it can be concluded that the sample comes from a normally distributed population. Detailed calculations can be seen in the attachment. Based on the table above, the price in the control class is 0.1459 for n = 30 with a significance level of 5%, the price based on the Lilieford test critical value table is 0.161. This shows that it is 0.161, so it is accepted. Based on these calculations, it can be concluded that the sample comes from a normally distributed population.

The use of STEM-based Augmented Reality media is something new for teachers and students. by using STEM-based Augmented Reality in mathematics learning, passive students become active and the classroom atmosphere becomes more interactive. Students are very enthusiastic about learning to use STEM-based Augmented Reality

because it is easy to understand the shape of 3-dimensional objects used in the application. The data obtained from the analysis were then analyzed using the normality test, homogeneity, NGAIN, independent T, and one sample T. According to the Lilieford critical test value table, the normality test based on the price above the price in the experimental class is 0.1018 for n = 30 with a significance level of 5% price. This shows that 0.161, as a result, is accepted. Based on this observation, it can be concluded that the sample represents a normally distributed population. accounting is a clear example of calculation. Based on the price table above, the price for the control class is 0. 1459 for n = 30, with a significance level of 5% for the price based on the Lilieford critical test table of 0.161. This shows that 0.161, as a result, is accepted. Based on this observation, it can be concluded that the sample represents a normally distributed population. The homogeneity test was found to have a significance level of 5%, and k = 2 is determined by the values = 1.860 and = 1.0012. This shows that acceptance is possible. This shows that the experimental and control groups have identical (homogeneous) variances. The N-Gain of the experimental class is better than the control class, namely the control class at 0.41 and the experimental class at 0.57. This can be stated that the proficiency of students in the experimental and control classes increased because the interpretation of 0-3, including the moderate category. Based on the results of the independent T, the sig value of 0.305> 0.05, it can be interpreted that the data variance between the experimental class and the control class is homogeneous. Then for the sig value (2-tailed) of 0.00001 <0.05, there is a significant difference. And the results of the one-sample T test showed that the results of learning completeness for the experimental class with a sig value (2-tailed) of 0.750, learning using Augmented Reality had achieved learning completeness. Then for the control class, the sig value (2-tailed) was 0.00001, so learning using conventional learning had not achieved completeness in learning.

This finding is in line with several previous studies, including Rosdiana (2022) who found that the use of STEM-based learning media can improve students' critical thinking skills and understanding of mathematical concepts, because the STEM approach links subject matter to more contextual real life. Nikmaturrobby (2024) in his research showed that Augmented Reality can increase students' interest and understanding of abstract material, especially in science and mathematics, because 3D visualization helps students process information more concretely. Majid (2022) emphasized that the Design Thinking approach in media development makes learning

products more user-centered and responsive to student needs. Media developed through the stages of empathy, ideation, and prototyping can increase student involvement and participation in the learning process. Febrianti (2021) proved that interactive digital books can improve numeracy literacy and enrich the learning experience because they combine text, visuals, and interactive elements that stimulate various student learning styles. Thus, after the learning is complete and the pretest and posttest are carried out, students are given a student response questionnaire regarding the use of STEM-based Augmented Reality used during learning. After that, the practicality questionnaire was analyzed and it was found that the learning media using STEM-based Augmented Reality showed a percentage of 88% in the "Very Good" category. So that practical learning media is used in learning. After going through the stages of research and development of digital learning media, Augmented Reality books with a STEM basis in improving mathematical literacy skills meet the valid, effective, and practical aspects used in learning.

CONCLUSION

Based on the results of the analysis and discussion in this study, it can be concluded that the development of media using digital books based on PJBL-STEM assisted by Augmented Reality is feasible (valid) to be used based on Media and Material Experts. Media experts with a percentage of 93.5% and a percentage of material experts of 95%. practical to use based on student response questionnaires. With a calculation of around 88% with the category "Very Good.. The development of media using digital books based on pjbl stem assisted by Augmented Reality is declared effective in increasing students' mathematical literacy skills. This is proven by the results of field trials in the experimental class which state that digital book media based on pjbl stem assisted by Augmented Reality has met the effectiveness indicators, namely the completion of mathematical literacy skills of students in the experimental class is better than the control class and there is an increase in students' mathematical literacy skills in the experimental class and the control class is known from the results of the N-Gain analysis in the "Medium" category. Recommendations for Further Research can be developed across subjects: Further research can develop digital book media based on STEM with the help of Augmented Reality in other subjects such as Science, Physics, or Geography to see the effectiveness across fields of science. This research can be replicated at different levels of education, such as high school or elementary school, to see the wider benefits of the media. Further research can focus on the influence of this media on students' collaboration, creativity, problem solving, or critical thinking skills. Can be Implemented in Schools This digital book media can be used as one of the alternative learning

resources in the school curriculum, especially to support project-based and technology-based learning. Training is needed for teachers to be able to utilize and develop similar media independently, including basic skills in using AR and the Design Thinking approach.

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