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Development of an PBL-Based Augmented Reality Media for Enhanced Social and Natural Science Learning Outcomes in Elementary School Students

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Abstract: Development of an PBL-Based Augmented Reality Media for Enhanced Sosial and Natural Science Learning Outcomes in Elementary School Students. Objectives: This research aims to develop ARIFAL media, which is packaged in the form of Augmented Reality and interactive PowerPoint Presentation based on Problem-Based Learning to improve the learning outcomes of social science students in grade IV. The media is designed to make learning more interactive, engaging, and effective in enhancing students' conceptual understanding. **Method:** The study uses Research and Development (R&D) with the Borg and Gall model, involving 5 students in a small-scale trial and 20 students in a large-scale trial at SD Negeri 2 Tubanan. Data collection was conducted through tests and non-tests, including observations, questionnaires, interviews, and documentation. The effectiveness of the media was evaluated through expert validation and improved student learning outcomes. **Finding:** The results of specialist validation show that this media is highly feasible for use, with material validity of 88% and media validity of 96%. The trial implementation demonstrated a significant increase in students' learning outcomes, with an average pretest score of 46.40 increasing to 85.40 in the posttest, and an N-Gain of 0.74 (high category). Furthermore, teachers and students gave very positive responses, indicating that the media is both useful and engaging. **Conclusion:** It can be concluded that ARIFAL media, which integrates Augmented Reality and interactive PPT based on Problem-Based Learning, effectively improving social science learning outcomes. This media can be applied in elementary school education to increase student engagement and understanding.

Keywords: augmented reality interactive PPT, science and technology learning outcomes, problem-based learning model.

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INTRODUCTION

Education has a strategic role in shaping quality human resources. It is an interactive process that involves a close relationship between students, teachers, and the material being studied. In teaching and learning activities, teachers need to have the right approach so that students can achieve their goals and obtain maximum learning outcomes. The implementation of education must be managed by the National Education System Agency (Ramadani et al., 2024).

A culturally based education system can strengthen national identity, advance nationality, and instill a sense of responsibility in the younger generation of Indonesian citizens (Riyanti et al., 2021). Through education that instills cultural values and local wisdom, the younger generation can better understand and appreciate the

nation'scultural heritage, which in turn shapes their sense of responsibility as Indonesian citizens.

This is in line with the goal of IPAS in the Independent Curriculum, which aims to be more connected to their surrounding environment, including family, school, and the wider community. In line with the purpose of social studies itself, namely so that students can emulate and preserve the culture and history of the Indonesian nation(Surya Adnyana, 2020). In addition, social studies also function to facilitate understanding of social interaction, as well as form attitudes that reflect the identity of the Indonesian nation in every aspect of daily life. Thus, social studies learning contributes to the development of an integral social understanding, which is not only useful for individual students but also for a more harmonious social life.

To support the success of achieving learning goals in the Independent curriculum, there are several important components in learning, including learning media. Learning media or the media in question is a tool used as an intermediary for teachers in delivering learning so that it is easily accepted by students. Rusdiana et al (2022) stated that the media is an inseparable part of the teaching and learning process to achieve general education goals and learning goals.

Along with the development of the times, especially in the digital era, Liu & Mu (2022) emphasized that the use of technology in education allows students to access materials in a more dynamic way as well as generate a deep understanding. Through interactive media, students can explore their various cultural values in more depth, thereby enriching their understanding of national identity in an increasingly globally connected world. This approach not only increases students' interest in learning but also facilitates more meaningful learning.

Technology is an important means of supporting learning innovation. For now, the platform that is still echoing in several training implementations for teachers is Canva (Arifin et al., 2020). This medium allows the integration of visual, audio, and animation elements that can increase student engagement and motivation in understanding the subject matter (Kristiana, Haning Hasbiyati, & Benny Afandi, 2022) .

The Canva platform offers many types of designs, one of which is an interactive PPT that can be modified with animation, audio, video, and images which if used to create media can certainly produce interactive learning media (Arifin et al., 2023). In addition, Canva has advanced features to create interactive PPT, graphic design, animated videos, amd provide various audio and 3D designs (Rusdiana et al 2021). The features provided by Canva are very helpful for creating attractive products (Sihombing et al., 2024).

In addition to the Canva platform, there is Augmented Reality that is being studied a lot to be applied to interactive learning media (Gede et al., 2021). Augmented Reality has several advantages that are not found on other platforms, namely it can provide an interactive 3D display or an image that resembles a real form so it is very suitable for use as a learning medium because it can increase student interest (Alfitriani et al., 2021).

In learning, a teacher plays an important role in supporting success in learning. A teacher must also continue to learn and adapt learning to the progress of the times. The factors that affect learning outcomes are not only what students get, but teachers must also pay attention to factors in learning such as learning objectives, teaching materials, learning media, or methods, the selection of learning models used by teachers during learning needs to be considered (Saktilia et al., 2024). According to research by(Sari, Sumarmi, Utomo, & Astina, 2021), the Problem-Based Learning (PBL) learning model combined with digital media is able to encourage students to think critically, solve problems, and learn actively.

In line with the research of Sari et al. (2021), one of the effective innovative approaches is the

application of Problem-Based Learning (PBL), which is able to improve students' critical thinking skills, collaboration, and mastery of subject matter. So that if students can master the material, it automatically allows students to be actively involved in the learning process through real problem-solving, which is integrated with the use of interactive media to reinforce learning outcomes (Zaniyati & Rohmani, 2024). In addition, the use of technology in PBL-based learning provides opportunities for teachers to create a dynamic learning environment in accordance with the needs of the digital century (Indahwati, Rachman, Tuasikal, Arif, & Ardha, 2019).

However, the results of observations, interviews, and documentation at SD Negeri 2 Tubanan, researchers showed that the problems found in IPAS learning, especially in social studies, still face obstacles, and one of the main problems is not optimal student learning outcomes. This can be seen from the daily test scores on each scope of material in the IPAS subject that has not reached the predetermined Learning Objective Achievement Criteria value of 75. So the role of the teacher here is very necessary because the teacher has 4 competencies namely pegadogies, personality, social, and professional that can be actualized to improve the quality of education. (Mukhtar et al., 2020).

Based on data obtained by researchers in the pre-research process by conducting interviews on the learning outcomes of grade IV students, the learning outcomes of grade IV students in science and social studies subjects are low, on the Even Semester Final Examination scores of science subjects for grade IV students of SD Negeri 2 Tubanan in the 2023/2024 academic year with a total of 25 students, where 9 students (64%) have not completed the learning objective achievement criteria and 16 students (36%) have completed the learning objective achievement criteria. Meanwhile, on the formative assessment of social studies subjects in grade IV in the 2024/2025 academic year, the scope of the material "Biodiversity" averaged 72, the scope of the material "Roles and Duties in School and Society" averaged 62, and the scope of the material "Rules and Responsibilities" averaged 70

In addition, the results of interviews with teachers show that students are less motivated to learn IPAS, especially when the teaching methods used are still conventional and less interactive. Meanwhile, the use of technology in learning today is very important and needs to be endeavored to support success in learning (Sahelatua et al., 2018). Further analysis shows that one of the main causes of this problem is the unoptimal use of learning media. So far, learning at SD Negeri 2 Tubanan still relies on the lecture method and textbooks without any interactive media that can improve student understanding. In fact, learning without variation will greatly affect students' motivation in learning so is necessary to have varied learning, both classroom conditions, assessments, learning media, and even learning models need to be considered (Susanti et al., 2024).

From the results of the review of these articles, there are several previous studies that prove that the results of the development of Canva-based learning media and Augmented Reality have succeeded in improving student learning outcomes and motivation. These researchers include Fetty Setiawati & Melva Zainil (2024a) in their research on Augmented Reality-based learning media in elementary mathematics subjects that succeeded in increasing learning outcomes by 88.16% and 93% for their effectiveness. The study by Fatih, & Alfi (2023) also confirmed that the development of Augmented Reality media using the Problem Based Learning model is very effective and was stated to be 88.49% feasible and valid to be applied in learning. The same research shows that the student response to Augmented Reality-based

learning media is very high and shows that this media is very attractive, which is 93.4%. (Gede et al., 2021). Meanwhile, research that tested the validity of Canva-based media showed that the results showed that it was 97.65% valid and very feasible to use (Azizatullatifah et al., 2024). Research on Canva-based media development is very effective in improving learning outcomes and student learning motivation through a problem-based model (Ansya et al., 2025).

In this study, ARIFAL (Augmented Reality Interactive for Learning) learning media based on Augmented Reality and interactive PowerPoint (PPT) based on Problem-Based Learning (PBL) were developed to improve the learning outcomes of IPAS grade IV students. In contrast to conventional learning media, ARIFAL allows students to interact directly with learning materials through realistic and interesting 3D visualizations. The use of the PBL approach is also expected to improve students' critical thinking and problem-solving skills in understanding IPAS material.

However, so far there are still limitations in research related to the effectiveness of AR-based learning media in learning IPAS at the elementary school level. Most existing studies focus more on the use of AR in subjects such as science and mathematics (Fetty Setiawati & Melva Zainil, 2024b), so it is necessary to conduct further studies on the application of AR in IPAS learning which is more complex and oriented to social life. Therefore, this study aims to fill the gap by testing the validity, effectiveness, and user response to ARIFAL media in the context of IPAS learning.

To answer the problems that have been identified, this research formulates the following research questions: 1) What is the validity of ARIFAL learning media according to material experts and media experts? 2) How is the effectiveness of ARIFAL learning media in improving IPAS learning outcomes of grade IV elementary school students? 3) How do teachers and students respond to the use of ARIFAL learning media in IPAS learning?

This research is expected to contribute to the development of technology-based learning media innovations, especially in improving the effectiveness of IPAS learning in elementary schools.

METHOD

Participants

This research was conducted at SD Negeri 2 Tubanan, with the research population being all fourth-grade students. Samples in this study were selected purposively to ensure the representation of various levels of cognitive abilities of students. In the small-scale trial, 5 grade IV students were selected with the help of the class teacher based on high, medium, and low cognitive levels, to see the effectiveness of ARIFAL learning media in various conditions of student understanding. Furthermore, in the large-scale trial, the sample consisted of 20 grade IV students, consisting of 10 female students and 10 male students with various levels of cognitive ability. This sample was chosen to get more representative results regarding the effectiveness of learning media in improving IPAS learning outcomes.

Research Design and Procedures

This research uses the Development method or Research and Development which develops interesting and interactive technology-based learning media using the Problem Based Learning model for class IV SD Negeri 2 Tubanan. In the development method by Borg and Gall, there are 10 stages that must be done.

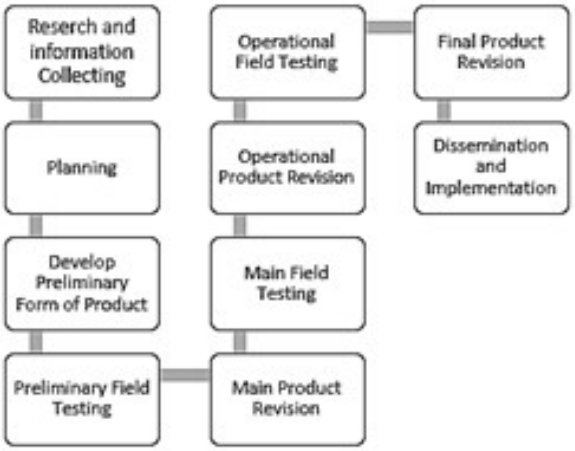

Figure 1. Borg and gall's development steps

There are eight stages of the modified Borg and Gall stages used in this study to speed up the research without reducing the essence of the research. Research at the undergraduate level has limited time and production costs, so relief is given to be able to carry out the Borg and Gall stages according to the needs of the researcher(R. K. Dewi et al., 2024). Supported research conducted by Tussifa et al (2021) explains that the stages of Borg and Gall research can be carried out according to needs and for undergradu research, the majority do not reach the 10 stages of Borg and Gall. So only essential stages such as planning, initial development, trials, and evaluation are prioritized until they get the results of the effectiveness of the developed media.

Figure 2. Development process with the borg and gall method

The researcher limits the development stages of Borgh and Gall in the development of Arifal media which is manifested in the form of interactive PPT and flashcards based on Canva and Augmented Reality, the stages are; (1) Possible problems, according to Saktilia & Wulandari (2024) The existence of an RnD study must depart from a possibility of a learning outcome problem. These problems are usually related to the need to find a solution to a problem at hand, with product development or updates. (2) Observation and analysis of needs, research that has gone through the process of excavation or observation related to potential existing problems is then analyzed with the aim of providing solutions to existing problems, which are expected to make a significant contribution to the development of science and practice in the field through the products developed. (3)Product Design Development, products that are determined as solutions to problems are developed according to needs, therefore product design needs to be considered for quality through the process of completing the development of learning media that will be tested by experts. (4) Design Revision, design revision is carried out if there are shortcomings and suggestions from the supervisor (5) Product Design Validation, designs that have been revised and ready to be tested are validated by media experts first to find out the feasibility of the media that has been designed. (6) Small-Scale Trial, products that are declared feasible by media expert validators are tested on a small group of field subjects as many as 5 students, to find out the quality level of product readiness before being tested on a large scale. (7) Product Revision, after the product trial, the results of the data obtained will be known to be improved to better support learning. (8) Large-Scale Trial, the most effective step in the development of learning media by testing the media with 20 students.

Instrument

In this Arifal media development research using interview, observation, questionnaire, and documentation instruments. The interview instrument was used to collect information about obstacles in the learning process from the class teacher and fourth-grade students of SD Negeri 2 Tubanan. The results of the interview were analyzed qualitatively which will be used to complement further data in product development (Saktilia & Wulandari, 2024).

There are three types of questionnaires in this study, namely needs questionnaire, validation questionnaire, and response questionnaire. The needs questionnaire was given to teachers and fourth-grade students of SD Negeri 2 Tubanan during pre-research, the validation questionnaire was given to the validator when conducting a validity test to assess the feasibility of the learning media developed, while the response questionnaire was given to teachers and fourth-grade students of SD Negeri 2 Tubanan when completing the large-scale test phase to find out the response to Arifal media based on Problem-Based Learning in the learning that has been done. The three questionnaires contain an assessment of the validity and feasibility of the media developed. This instrument is adapted from Sugiyono's (2019) assessment standards, with a Likert scale of 1-4 tested quantitatively and an average percentage. The validity of the instrument was tested using content validity through Expert Judgment, which stated that the instrument was suitable for use without significant revision. Reliability was tested using Cronbach's Alpha, with a result of 0.82 (highly reliable category), indicating that the instrument has high consistency in measurement. Meanwhile, documentation was used to support the data obtained and develop the media (Sabilah & Rifah, 2024). Documentation taken as support is IPAS learning outcomes both daily formative grades and summative grades in the past learning year to find out the extent of the problems faced in learning through documentation studies of student learning outcomes, as well as documentation of the process of implementing learning in the classroom and classroom infrastructure.

The test instruments in this study were in the form of pretests and posttests, the questions used for pretests and posttests were tested to measure the level of validity, differentiation, reliability, and level of difficulty. From these results, there are 32 out of 40 valid questions so researchers determine 25 of the 32 valid questions to use. The results of the pretest and post-test scores will be tested quantitatively in the form of normality, homogeneity, T-test, and N-Gain test.

Analysis Data

In this study, quantitative and qualitative data analysis was used with test and non-test techniques. Rukminingsih et al (2020) stated that the test technique was carried out by pretest and posttest, while the non-test technique was carried out by observation, interview, documentation, and questionnaire.

The recapitulated results of the needs questionnaire were used to develop interview instruments and determine product development. The validation questionnaire is used to see the results of the validator's score on the developed media, the results of the validator's daily score are averaged so that it will be found in the classification of the feasibility level. The criteria used in the questionnaire are vulnerable <59% are classified as "not feasible", 60% - 75% are classified as "quite feasible with revision", 76% - 85% are classified as "feasible with revision", and 86% - 100% are classified as "very feasible without revision", and Arifal media has passed the validation stage of two experts, namely media experts with a percentage of 88% who are classified as "very feasible without revision" and 90% of the percentage from material experts.

Table 1. Teacher and student response criteria - König et al (2020)

Percentage	Criteria
0% - 20%	Not eligible
21% - 40%	Less feasible
41% - 60%	Enough
61% - 80%	Proper
81% - 100%	Highly Worthy

Meanwhile, the teacher and student response questionnaire was sent to find out the response or response to the Arifal learning media developed by the researcher in this study.

Data from the pretest and post-test results were used to measure changes in student learning outcomes and were analyzed using the N-Gain test. In accordance with research conducted by Dewi et al (2024) state to analyze whether there is an increase in student learning outcomes, namely by the N-Gain test. According to Saktilia et al (2024), the calculation with N-Gain can be formulated as follows.

Table 2. N-Gain value

No.	Aspect	Category
1	$g > 0.70$	High
2	$0.30 \leq g \geq 0.70$	Keep
3	$g < 0.30$	Low

RESULT AND DISCUSSION

Arifal learning media based on Augmented Reality and Canva has the advantage of creating a more interactive and interesting learning experience. Arifal stands for (Augmented Reality Interactive for Learning) for fourth-grade students of SD Negeri 2 Tubanan. In this study, Arifal media was developed after conducting a series of initial data collection sourced from teachers and students in fourth-grade of SD Negeri 2 Tubanan. The results of the initial data analysis found that the problem of social studies learning outcomes was still low in social studies, lack of motivation in the learning process of science in the classroom, not optimizing the use of technology-based learning media in learning, and the use of monotonous learning models. So the RnD research method by adapting the development model from Borg and Gall based on Problem-Based Learning was chosen by the researcher as a solution.

In line with what was stated by Saktilia et al (2024) Borg and Gall's development steps are tailored to the needs, so the development of this study begins with possible problems; observation and analysis of needs; product design development; revision of product design; product design validation; small-scale trials; product revision; large-scale trials.

Observation and Problem Identification

After conducting observations, interviews, and literature studies at SD Negeri 2 Tubanan, Jepara Regency, in the even semester of the 2024/2025 school year, the researcher identified several problems that affect the learning process. The data collection methods used include direct observation of teaching and learning activities, interviews with teachers and students to understand their perspectives, as well as literature studies to obtain relevant theoretical foundations, and questionnaires to find out what teachers and students need (Romdona et al., 2025). The problems encountered are not only sourced from teachers but also from students, such as learning that has not optimized learning media because of the limited time learning media is very helpful for teachers in learning, even though the problem was raised by Viola et al., (2024) Time limitations are also an obstacle for teachers in preparing effective learning media, but the results of his research with the existence of learning media make learning more meaningful and interactive. The low learning results are evidenced by the results of the Summative Results of Final Semester of the Even SAS Semester for the science subject of grade IV students of SD Negeri 2 Tubanan for the 2023/2024 academic year with a total of 25 students, of which 9

students (64%) have not completed the learning objective achievement criteria and 16 students (36%) have completed the learning objective achievement criteria. In addition, there is also the use of a teacher-centered learning model, and a lack of student motivation to learn.

Data Analysis

The collection of information from observations, interviews, and data from the needs questionnaire stated that there are quite a lot of social studies materials but the results are not optimal, there is a lack of teaching aids or learning media that can be used, teachers need technology-based learning media innovations to be more interesting and interactive. It is hoped that the innovation of teaching media can increase students' learning motivation as evidenced by learning outcomes that can meet the learning objective achievement criteria. The use of technology-based learning media in social studies lessons is very helpful for students not to get bored easily and make it easier to understand the material (Puspitarini et al., 2019).

The researcher determined the development of technology-based learning media that refers to learning outcomes and learning objectives as a solution from the data obtained. According to Tungka, Yunus, & Hamid (2024), complete technology-based learning media not only integrates text but also has illustrations in the form of 2D and 3D images, videos, and audio so as to facilitate all different learning styles of children.

Design Development

In the design development stage, researchers begin to design the initial design as the basis for making products before being further tested. The products to be developed are Arifal media in the form of interactive PPT and Augmented Reality which utilizes the Canva and Assemblr Edu platforms based on the Problem-Based Learning model. This media adjusts learning outcomes and learning objectives to the Culture and Local Wisdom material. The media design designed interactive PPT can be used by teachers while Augmented Reality can be used by teachers and students. Interactive PPT will be designed by integrating text, 2D, and 3D images with Augmented Reality, video, and audio. Start by collecting materials that will be included in the product such as PPT designs made in Canva, 3D images are taken and designed in Sketchup then enter the Augmented Reality design process in Asemblr Edu, the materials that will be loaded are obtained from various sources that are relevant, valid, and quality. Meanwhile, Augmented Reality for students will be made in the form of flash cards containing barcodes that will be scanned by students to display 3D illustrations. Step one, create a 3D design in Sketchup

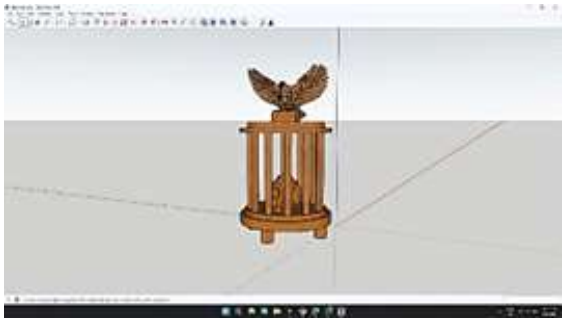

Figure 3. 3D object design

The second step, enter the Assemblr Edu platform to design a 3D image from Sketchup with glb format to Augmeneted Reality as desired. Step Three, download the barcode or QR.

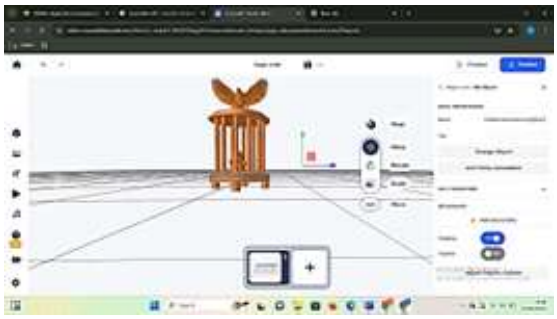

Figure 4. 3D Design augmented reality

Figure 5. Download the barcode or QR

The next step, design the flash card to print. Next, create a PPT background design in Canva with the theme of local wisdom. The content that will be displayed in the interactive PPT contains materials in the form of text, video, audio, quizzes, 2D and 3D images that are animated.

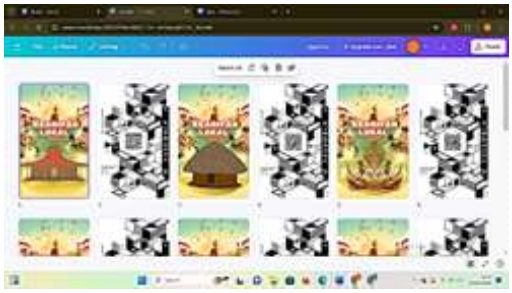

Figure 6. Flash card design

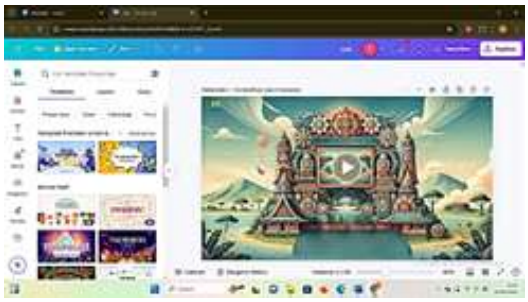

Figure 7. Power point design

Figure 8. Power point content

Design Revision

At the design revision stage, product improvements are carried out based on input from supervisors before conducting expert validation tests. Improvements include aspects of visual appearance, content suitability, and font usage. In this study, the revision was applied to interactive PPT and Augmented Reality (AR) based on Problem-Based Learning (PBL) developed using Canva and Assemblr Edu. The suggestions indicate aspects that need to be improved, such as adding AR content, adjusting colors and fonts to make it more comfortable for users, and simplifying instructions to make it easier for students to understand. According to Lee, Lim, & Kim (2017) research, the design revision process based on expert and user feedback is crucial in improving the effectiveness of technology-based learning media, as it allows developers to tailor the product to real needs in the field before full implementation.

Expert Validation

At the expert validation stage, the products that have been developed are tested by experts to ensure their quality, effectiveness, and integration with learning objectives. Validation was carried out by material experts and media experts to assess the suitability of the content, presentation structure, and technical aspects of interactive PPT and Augmented Reality (AR) based on Problem-Based Learning (PBL) developed using Canva and Assemblr Edu. This validation process refers to the criteria for content validity, usability, and effectiveness in improving student understanding. According to the research of Barroso et al (2019), validation by experts is very important in development research because it can improve the quality of the product before it is tested to users, as well as ensure that the learning media developed is in accordance with the needs of technology-based education.

Based on the results of validation by media experts, a total score of 56 out of a maximum score of 64 was obtained. The aspects assessed

include the quality of content and instructional objectives which obtained a score of 14, technical aspects or media display with a score of 25, and aspects of media integration in learning with a score of 17. From these results, a feasibility percentage of 88% was obtained, which indicates that this learning media is included in the "very feasible" category without the need for further revision.

The results of validation by material experts show that this media obtained a total score of 70 out of a maximum score of 72. The aspects assessed include the suitability of the material with learning objectives that get a score of 12, suitability with the level of thinking of students with a score of 7, the completeness of the media content with a score of 39, and the suitability of the stimulus provided with a score of 12. Thus, this learning media obtained a feasibility percentage of 96%, which is classified in the "very feasible" category without the need for further revision.

From the results of the media expert test and the material expert test on the Arifal media developed, the results show the criteria above 80% which indicates that the media is very valid without revision. With these results, Arifal media is ready to be tested at the next stage, namely small-scale trials.

These results are in line with research conducted by Fetty Setiawati & Melva Zainil (2024b) who also found that Augmented Reality (AR) based media in learning mathematics in elementary schools has a high level of validity (88.16%) and strong effectiveness in improving student understanding (93%).

In addition, research by A1, Fatih, & Alfi (2023) also shows that the use of AR in the Problem-Based Learning (PBL) model has a feasibility level of 88.49%, which is in line with the validation results in this study. Thus, it can be concluded that AR-based learning media has great potential in increasing student engagement and clarifying the concepts learned.

Small-Scale Trial

Products that have been validated by media experts and subject matter experts are tested on a limited group to measure practicality, effectiveness, and user response before wider implementation. In this study, a trial was carried out on Problem-Based Learning (PBL)-based Arifal media using Canva and Assemblr Edu on teachers and students of grade IV of SD Negeri 2 Tubanan, students who were taken by a total of 5 students. Data collection was carried out through observation, satisfaction questionnaires, and analysis of student learning outcomes. The results of the initial trial showed that most students felt more interested and motivated in learning, and were able to understand the material better than conventional methods. It is proven from the results of the questionnaire that the teacher response shows 90% (Very feasible) and students 89% (Very feasible) from the following response criteria.

It is said to be very feasible because the percentage results show above 80%. Meanwhile, the learning outcomes of students in this small-scale trial obtained a pretest score with an average of 52.00 and an average posttest of 91.20. From the average results of the pretest and post-test, there was a significant increase in learning outcomes with a difference of 39.20. In addition, the researcher analyzed the N-Gain value obtained in a small-scale test, which was with an average of 0.82 (high). With quite good results, it shows that the existence of Arifal media based on the Problem-Based Learning (PBL) model in learning science and science, cultural diversity, and local wisdom materials are very helpful in spreading at SD Negeri 2 Tubanan.

Product Enhancements

At the stage of product improvement testing, learning media that has been tested on a small scale is then reviewed to ensure its readiness before wider implementation. In this study,

Figure 9. Implementation of small-scall test

interactive PPT and Augmented Reality (AR) based on Problem-Based Learning (PBL) developed using Canva and Assemblr Edu have passed expert validation and small-scale trials with very feasible results without the need for further revision. The results of the evaluation show that this media meets the standards of content quality, ease of use, learning effectiveness, and visual appeal, as assessed by teachers and students. According to Williamson, Bayne, & Shay (2020), a development product that achieves a high level of feasibility in the initial trial still needs to be reviewed to ensure its stability in various learning conditions. Therefore, even though no revisions are needed, improvements are made in terms of word spelling and usage guidelines so that the implementation in the classroom can run optimally.

Product Implementation

The implementation of Arifal media was developed in grade IV of SD Negeri 2 Tubanan with 20 students in the subject of science and science, cultural diversity, and local wisdom. In the implementation of this large-scale product, researchers will conduct full learning which begins with a pretest and ends with a posttest to obtain data on whether or not by using Arifal media, the results of learning science and technology, cultural diversity, and local wisdom will increase or not.

The learning process on a large scale is the same as in a small-scale trial, which only increases the number of subjects. At this stage, the researcher obtained results analyzed using N-Gain from the results of the student pretest and post-test,

Figure 10. Result of large-scale test analysis

The results of the large-scale product implementation showed a significant improvement in student learning outcomes after using Arifal media in learning science in grade IV of SD Negeri 2 Tubanan. Based on the analysis using N-Gain, there was an average increase from 46.40 in the pretest to 85.40 in the posttest, with an N-Gain value of 0.74 or 73.67% which is included in the high category. These results indicate that the use of Arifal media is effective in increasing students' understanding of cultural diversity and local wisdom materials. According to Lee et al (2017), An N-Gain value above 0.70 shows high effectiveness in improving learning outcomes, which means that this learning medium successfully provides a more interactive learning experience and motivates students to better understand the concepts taught. Another study by Sihombing & Fauzi (2024) also confirmed that the use of technology-based interactive media in exploration-based learning is able to increase knowledge retention and transfer. Therefore, the results of this implementation show that Arifal media not only improves concept understanding but also contributes to increasing student involvement in technology-based learning.

Supported by the results of the questionnaire of teachers and students' responses to Aripal's media which are very good. Teachers assessed that Aripal's media was very helpful in delivering material in a more interactive manner,

increasing student involvement, and making it easier to understand the concept of cultural diversity and local wisdom with a percentage of 92% (very feasible) questionnaire results. The students' responses also showed that they were more motivated and enthusiastic in learning using this media compared to the conventional method with a 90% percentage of questionnaire results. This is in line with the research of Zainuddin et al (2018) which stated that technology-based learning media that are designed interactively can improve students' learning experience and memory. With the support of the results of this questionnaire, Arifal media can be considered an effective learning innovation and has the potential to be applied on a wider scale.

CONCLUSION

Based on research, ARIFAL media based on Augmented Reality and interactive PPT with PBL models are proven to be valid, feasible, and effective in improving social science learning outcomes. The validation of material and media experts showed high validity (88% and 96%). Small and large-scale trials showed an increase in the average value from 46.40 to 85.40, with an N-Gain of 0.74 (high category). The positive response from teachers and students corroborated that ARIFAL not only improves the understanding of concepts, but also the motivation and involvement of students in learning.

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