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Development of PBL-Integrated Augmented Reality Media to Improve Mutual Cooperation and National Ideology Education Learning Outcome for Fifth-Grade Students

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Abstract: Development of PBL-Integrated Augmented Reality Media to Improve Mutual Cooperation and National Ideology Education Learning Outcome for Fifth-Grade Students.
Purpose: The purpose of this study was to develop Augmented Reality media with a Problem Based Learning model to improve the dimensions of mutual cooperation and learning outcomes of fifth grade students at SDN Pandansari 01, Batang Regency, in national ideology education, specifically the material on mutual cooperation in the surrounding environment. **Methods:** This study used a Research and Development (R&D) approach using the Borg & Gall model for development, which consists of eight stages, namely 1) Potential and problems; 2) Data collection; 3) Product desain validation; 4)Product design validation; 5) Design revision; 6) Product testing; 7) Product revision; 8) Usage testing. **Findings:** The learning device developed in the form of AR-based flashcards containing examples of mutual cooperation application in the surrounding environment. Evaluation by subject matter experts yielded a a score of 85.4 while media experts scored. 90.2 indicating that the material and media validation results fall into the highly suitable category. Testing was conducted on 31 fifth grade elementary school students, showing a significant increase in the mutual cooperation dimension and students learning outcomes. Statistical analysis based on the t-test showed a result of 0,001, indicating significant effect on the pretest and posttest result. The n-Gain test was 0,71, indicating a high category. **Conclusion:** The conclusion of this study is that AR-based learning media with PBL model is effective in improve learning outcomes and the application of mutual cooperation in national ideology education.

Keywords: augmented reality, mutual cooperation dimension, learning outcomes, national ideology education.

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INTRODUCTION

Education is one of the essential needs in life. According to the National Education System Law No. 20 of 2003, Chapter I, Article 1, education is defined as a deliberate and structured effort to create a learning environment that allows students to actively sharpen their potential through the development of psychological aspects, self-control, behavior, excellence, good attitudes, and skills, both individually and within society, the nation, and the state. Education plays a crucial role in national development. Schools and education directly enhance children's cognitive abilities and positively impact academic development Peng & Kievit, (2020). Education is a crucial aspect because it significantly

influences students' achievements and helps them reach their desired goals. Along with the rapid technological advancements, both teachers and students are required to master technology to improve the quality of education. The development of technology has had an impact on the use of learning media as a tool in the teaching process Williamson et al. (2024).

From the various opinions above, it can be concluded that education is a vital necessity in life aimed at developing students' potential comprehensively, covering psychological, moral, and skill aspects, as stated in the National Education System Law No. 20 of 2003. Education plays a crucial role in building quality human resources, supporting the process of individual maturation, and achieving academic goals. The use of learning media in the era of technological advancement is an effective approach to improving the quality of education for both teachers and students.

Learning media plays an important role as a bridge for teachers to convey information. As explained by Lin & Li, (2024) learning media functions as a tool for delivering learning material. Teachers who integrate learning media into the learning process can create more engaging learning experiences and broaden students' perspectives. Learning media includes various tools or means to convey material, stimulating cognitive aspects and students' interest. The application of media will facilitate teachers in delivering material and create an interactive learning environment Hanif, (2020). The use of learning media, combined with technological advancements, makes it easier for teachers to deliver material during the learning process.

The use of technology in education is an effective way to create a more meaningful learning environment and enhance students' cognitive abilities Zhao & Lai, (2023). Multimedia supports learning effectively when designed with the appropriate pedagogical approach and technology by the teacher Abdulrahaman et al. (2020). The application of technology- based learning media by teachers has a positive impact on students' progress, where students' cognitive abilities increase more rapidly through the application of this technology Perifanou et al. (2021).

With the development of technology, learning media has also undergone rapid development, and examples of current technology-based media that are now familiar include AI, AR, and VR. This study will implement one of these examples, which is AR Timotheou et al. (2023). According to Geroimenko (2020:4), Augmented Reality (AR) is a technological innovation that creates an interactive and engaging learning experience for students by integrating digital elements into the real world. Meanwhile, Verma & Paul (2022:5) state that AR is a technological development that presents a real environment and adds additional details to enhance and improve users' understanding. From these two opinions, it can be concluded that AR is an innovative technology that integrates virtual content with the real world, providing a more dynamic and interactive learning experience for students.

The use of media in education is highly recommended. ARbased learning media integrates virtual elements with the real world, producing information from data captured by the system about a specific object by combining the virtual and real environments Bailey et al., (2022). AR is a technological innovation that integrates the virtual world into the real world and projects it in real-time Koumpouros, (2024). The integration of AR in education provides a more interactive learning experience for elementary school students and can enhance their cognitive abilities Drljeviæ, et al., (2022). This is in line with the opinion of Rusli et al. (2022), who state that the application of AR provides a more enjoyable learning experience for elementary

school students and improves their learning outcomes.

The researcher has developed an AR-based flashcard learning media. The use of AR-based flashcard learning media in learning activities has proven effective as an educational tool that captures students' attention and improves their learning outcomes Ghosh et al. (2025). The application of AR-based flashcards in education provides a great opportunity to enhance students' learning experiences and outcomes by offering interactive and multimedia-rich media, making learning deeper Titchiev, (2024). Research by Riniati et al. (2024) suggests that the application of AR-based educational technology significantly improves student engagement in elementary schools. This shows that AR not only increases engagement but also has a positive impact on students' learning outcomes in the elementary education environment. Besides the use of learning media, the application of teaching models also supports the learning process.

In the learning process, teaching models help maximize students' cognitive mastery. The application of teaching models according to the constructivist methodology is appropriate Simanjuntak et al. (2021). One teaching model that is currently widely applied is Problem-Based Learning (PBL). PBL is an innovative learning model that increases active student participation by presenting real-world problems in learning so that students will have continuous involvement Mustofa & Hidayah, (2020). According to research by Smith et al. (2022), PBL is capable of presenting more effective learning by integrating knowledge and skills and improving students' learning outcomes.

The application of PBL can improve students' learning outcomes and critical thinking skills (Yusuf et al., 2020). PBL is effectively applied to elementary school students and can improve their learning outcomes Radiansyah et al. (2023). The implementation of PBL in learning not only enhances cognitive abilities but also fosters mutual cooperation among students Surur et al. (2020). Mutual cooperation is a traditional Indonesian practice that reflects the values of solidarity, togetherness, and social care to create a harmonious environment Alfinda Oktaviani et al. (2023). Mutual cooperation, by applying the PBL model at the elementary school level, can improve students' learning outcomes Rahmawati et al. (2024). Mutual cooperation is also one of the dimensions in the Pancasila Student Profile.

The Pancasila Student Profile refers to the attitudes and competencies developed through daily activities, internalized in students through school culture and learning activities, whether in the curriculum, co-curricular, or extra-curricular fields Rahayuningsih, (2022). One of the essential aspects of the Pancasila Student Profile (P3) is the spirit of mutual cooperation. Mutual cooperation as part of P3 will guide students to become individuals with social characteristics, humility, and readiness to help others.

Research by Maritasari et al. (2025) shows that the application of Augmented Reality as a learning medium is effective and can improve students' mutual cooperation attitudes in elementary schools. The similarity with this research is the use of Augmented Reality media and the implementation of mutual cooperation attitudes. The difference lies in the subject matter, the research location, and the focus of the research. This study develops an AR-based flashcard media in National Ideology Education, which contains examples of applying mutual cooperation in the surrounding environment—at home, school, family, the nation, and the state—accompanied by music relevant to the mutual cooperation examples. This study uses the Problem-Based Learning model in its implementation. The research location is at SDN Pandansari 01, Batang Regency, focusing on developing AR-based flashcards as an innovative

learning media that improves mutual cooperation dimensions and students' learning outcomes.

The results of interviews with fifth-grade teachers revealed a primary issue: the teachers have not fully optimized the use of technology-based media, resulting in students' lack of interest in studying National Ideology Education, leading to a lack of focus. The learning process still uses concrete media. Students also fail to apply the spirit of mutual cooperation in their surroundings. Based on these findings, the researcher offers a solution: there is a need for interactive media that can improve the quality of National Ideology Education learning so that the mutual cooperation dimension and student learning outcomes improve.

This study will answer the research question concerning how to design and develop an interactive Augmented Reality- based media to enhance fifth-grade students' learning outcomes in National Ideology Education, based on teachers' interviews. The feasibility and effectiveness of the media developed by the researcher will be evaluated in this study. Based on the explanation above, this research is important to develop ARbased flashcard media with a PBL model to improve the quality of National Ideology Education, particularly in teaching mutual cooperation, which aims to enhance the mutual cooperation dimension and students' learning outcomes.

METHOD

Participants

In this study, the research sample consists of 31 fifthgrade students from SDN Pandansari 01 in Batang Regency, with 20 female and 11 male students. The technique used for participant selection is purposive sampling. Purposive sampling is used to determine that the study focuses on a group of students participating in National Ideology Education learning with the same learning conditions and curriculum. This method was chosen to ensure the consistency of the research variables and to ensure that all students have the same educational background and receive the same subject matter Creswell et al. (2018). The study was conducted by dividing students into large and small groups, with both groups receiving the same treatment in learning. The small group consists of 6 students, categorized into 2 high, 2 medium, and 2 low students. The large group consists of 25 students. The study was conducted during the second semester of the 2024/2025 academic year.

Researach Design and Procedures

This research follows the Research and Development (R&D) approach with the Borg and Gall model, which includes 10 stages: 1) Potentials and problems, 2) Data collection, 3) Product design, 4) Product design validation, 5) Design revision, 6) Product testing, 7) Product revision, 8) Trial use, 9) Final product revision, 10) Mass production. According to Sugiyono, (2019: 752) Research and Development is a research method aimed at creating specific products and testing the effectiveness of the developed media. The Borg and Gall model consists of several stages, including potentials and problems, data collection, product design, validation, product testing, product revision, and trial use Sugiyono, (2019: 779).

This study follows the Borg and Gall framework, which includes 8 consecutive stages: potentials and problems, data collection, product design, design validation, product testing, product revision, and trial use. The researcher chose to use 8 stages of Borg and Gall due to time and budget constraints. The Borg and Gall model is a comprehensive and sequential approach to developing products, involving structured methodology and comprehensive assessments at each development stage Borg and Gall, (1998: 187). The choice of this model is based on its structured and systematic methodology, as well as its complete and thorough application and evaluation at each stage of development. This

R&D study uses the Borg and Gall model to develop interactive media with AR media applications following the structured steps, which include 8 stages: 1) Potentials and problems, 2) Data collection, 3) Product design, 4) Product design validation, 5) Design revision, 6) Product testing, 7) Product revision, 8) Trial use.

The first stage in Borg and Gall is "Potentials and Problems," which is designed to identify issues for developing a product that meets the students' needs Sugiyono, (2019: 778). The potential and problems in this study were identified through the distribution of questionnaires, observation, documentation, and interviews with teachers and school principals to understand the issues in National Ideology Education for fifth-grade students. The data collection stage involved need analysis through three questionnaires: mutual cooperation dimensions, learning media needs, and students' learning preferences. These indicators were based on Arsyad, (2020: 73–74). The need questionnaires were distributed to both teachers and students, focusing on four indicators: alignment with objectives, appropriateness for supporting factual, conceptual, principled, or generalized content, technical quality, and media suggestions.

The design stage includes visual design and learning scenario development. The visual design involved creating ARbased flashcards, and the learning scenario was developed in the form of a teaching module for practical implementation. The AR flashcard design was supported by the Canva and Assemblr Edu applications to add 3D elements. The product design validation was carried out by content and media experts. This validation stage is crucial to ensure the developed product meets the standards and needs of the learners Rayanto, (2020: 37). After validation, design revisions were made to address any shortcomings in the product, including the addition of 3D objects in the AR-based flashcards.

Product testing was conducted after the product design was completed to assess whether the developed product was suitable for use. The product testing in this study was conducted on a small-scale group of 6 students in fifth-grade at SDN Pandansari 01, focusing on National Ideology Education, particularly mutual cooperation in their surroundings, carried out on January 31, 2025. Since the teacher and student responses indicated that the product was well-received, no revision was necessary after product testing. The final trial use was carried out in a larger group of 25 students in the fifth grade on February 1, 2025.

Instrument

The assessment instruments used were both test and non-test techniques. The test instrument consisted of 25 multiple-choice questions that were relevant to the students. The cognitive tests in this study were designed with 50 multiple-choice questions. After validity testing at a 5% significance level, 25 questions were found to be valid and reliable, and only these 25 were used. The reliability score for the questions was 0.86508 with a 5% significance level, indicating that the cognitive test was reliable. The validity test used the point-biserial correlation formula, and reliability testing used Cronbach's Alpha formula. The cognitive test covered mutual cooperation in the surrounding environment for fifth-grade students, including examples of mutual cooperation in their home, school, family, nation, and country. The questions aimed to assess students' understanding, application, and analysis. The pretest and posttest results will be compared and analyzed for differences.

To measure mutual cooperation ability and learning outcomes, a mutual cooperation dimension questionnaire was used, consisting of 10 questions with a Likert scale (SS, S, TS, STS). The indicators for the questionnaire were based on Kemendikbudristek, (2022: 21-24).

For the learning outcomes questionnaire, pretest and posttest questions were developed from valid and challenging trial questions.

Non-test techniques were used for data collection through systematic observation. The study employed three types of nontest techniques: observation, interviews, and distributing questionnaires. Observations were conducted during the learning process by the teacher. Structured interviews were conducted with 20 questions for the teacher and 10 questions for the students, covering learning sources, teaching methods, and the learning atmosphere. The researcher used three types of questionnaires: needs questionnaires, mutual cooperation dimension questionnaires, and feedback questionnaires. The needs questionnaire consisted of 26 questions, and the feedback questionnaire contained 15 questions, both using a Likert scale. The mutual cooperation dimension questionnaire was based on Kemendikbudristek, (2022: 21-24) with 10 questions. All questionnaires used a Likert scale with 4 options (Strongly Agree, Agree, Disagree, Strongly Disagree).

Data Analysis

Data analysis involved three types of tests: feasibility testing, initial data analysis, and final data analysis. Feasibility testing was conducted through assessments by content and media experts, as well as respondents (students), to evaluate the quality of the developed learning media in terms of content, language, technical quality, and presentation. Initial data analysis included questionnaires on teacher and student needs, as well as the trial of test questions. The pretest and posttest questions were derived from trial questions previously tested on sixth-grade students, consisting of 50 multiple-choice questions. The class for the trial test was chosen based on the condition that students had already received mutual cooperation material in their daily lives. The trial test results indicated that 25 multiple-choice questions were valid and challenging. After the trial test, the researcher distributed the needs questionnaires to teachers and fifth-grade students. The students' needs questionnaire contained 21 questions using a Likert scale, covering three aspects: alignment with objectives, technical quality, and suggestions. The teachers' needs questionnaire consisted of 26 questions with a Likert scale covering aspects such as alignment with objectives, appropriateness for supporting subject content, technical quality, and suggestions. The validation of the media was conducted by testing the developed media with content and media experts. The media assessment used a validation questionnaire consisting of three indicators: media, presentation, and media use, rated on a scale of 1-4, with 23 questions. The content assessment included 4 indicators: appropriateness, completeness, feasibility, and competency, rated on a scale of 1-4, with 12 questions. The software used for statistical data analysis included Excel and SPSS, with normality testing, t-tests, and n-gain tests.

The interpretation of the media and content validation feasibility scores is as follows: 76%-100% is categorized as very feasible, 51%-75% is feasible, 26%-50% is moderately feasible, and 0%-25% is less feasible. Initial data will be analyzed by conducting a normality test on the pretest and posttest scores to measure students' learning outcomes. Normality testing will be calculated using the Shapiro-Wilk formula. Final data analysis will involve analyzing posttest data to assess the impact on students' learning outcomes after the intervention. Posttest data will then be analyzed using t- tests and n-Gain. The interpretation of the n-Gain index is as follows: N-Gain e" 0.70 is considered high, N-Gain between 0.30 and 0.70 is medium, and N-Gain d" 0.30 is low.

■ RESULT AND DISCUSSION

Model Borg and Gall is an approach for developing products through comprehensive and sequential steps (Borg and Gall, 1998). The research and development procedure is divided

into 8 stages, namely: (1) Potentials and Problems; (2) Data Collection; (3) Product Design; (4) Product Design Validation; (5) Design Revision; (6) Product Testing; (7) Product Revision; (8) Trial Use. The stages are explained as follows:

Potentials and Problems

In this stage, the researcher conducted preliminary research through interviews with the fifth-grade teacher at SDN Pandansari 01 and distributed questionnaires regarding the needs of both the teacher and students for the development of AR-based flashcard learning media using Assemblr Edu in the National Ideology Education subject, focusing on the topic of mutual cooperation in the surrounding environment. The results of the interview with the fifth-grade teacher revealed several issues in National Ideology Education, including the teacher's limited use of technology-based media. The teacher predominantly used concrete media, the application of mutual cooperation attitudes among students was still low, and the learning outcomes in National Ideology Education were still considered low. Interviews are crucial to identify the existing problems in the class. Based on these identified issues, the researcher developed an AR-based flashcard learning media for National Ideology Education in grade V, specifically focusing on mutual cooperation in the surrounding environment. Therefore, this research is significant. This aligns with the opinion of Liono et al. (2021) who stated that AR can address issues in learning as an innovative media that assists students. Another study by Wahyu et al. (2020) also stated that problems in learning can be overcome with the presence of AR.

Data Collection

At this stage, the researcher collects data as the basis for developing the design of the AR-based flashcard learning media, obtained through questionnaires, documentation, and interviews with fifth-grade teachers and the principal. In this stage, the researcher distributes questionnaires to students and teachers to understand what type of learning media is suitable for the students. The questionnaire was filled out on December 21, 2024, by the teachers and 31 fifth-grade students. The results of the student needs questionnaire are as follows: The "SS" option, worth 4 points, received a total of 310 points. The "S" option, worth 3 points, received a total of 231 points. The "TS" option, worth 2 points, received a total of 35 points. The "STS" option, worth 1 point, received a total of 21 points. The total score from the student needs questionnaire was 1990, with a mean score of 3.0, indicating that it is highly suitable (SS).

The results of the student needs analysis indicate that the majority of students strongly agree on using learning media that integrates technology, in the form of augmented reality-based flashcards, to enhance mutual cooperation and improve student learning outcomes. The students have a high level of curiosity and are very enthusiastic about using the media that will be developed by the researcher. Therefore, the presence of this learning media is expected to spark enthusiasm for learning, leading to better learning outcomes for the students. The results of the teacher needs questionnaire are as follows: The "SS" option, worth 4 points, received a total of 72 points. The "S" option, worth 3 points, received a total of 12 points. The "TS" option, worth 2 points, and the "STS" option, worth 1 point, received a total of 0 points. The total score from the teacher needs questionnaire was 92, with a mean score of 91, indicating that it is highly suitable (SS).

Data collection is essential to assess the results of the needs questionnaires and provide appropriate solutions to the existing issues. The results of the teacher needs analysis show a strong agreement towards the interactive AR-based media designed by the researcher to be applied in order to optimize student learning outcomes. Teachers expect the learning media

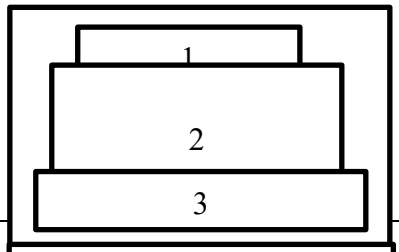
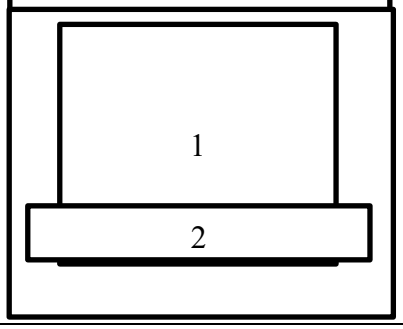
to be colorful and suggest that AR-based learning is excellent for use at the elementary school level, as it helps all students understand the concept of mutual cooperation in-depth, thereby enhancing student interest in learning. Based on this analysis, the researcher decided to develop AR-based flashcards on the implementation of mutual cooperation in the surrounding environment, accompanied by songs and moving objects. This aligns with research by Cai et al. (2021) which states that th application of AR provides a deeper understanding and increases student interest.

Product Design

Based on the needs questionnaire results, the researcher created the design for the AR-based flashcard learning media. In this stage, the researcher designed the product prototype by creating AR-based flashcards. The AR media design was made simple but contained important elements and was easy to use. This aligns with research Kerr & Lawson, (2020) who stated that AR media designs that incorporate key frameworks in learning can create engaging learning experiences.

The flashcards designed consisted of 20 items, tailored to examples of mutual cooperation in the surrounding environment (home, school, family, nation, and state). The initial creation of the flashcards was done using the Canva application, with components such as the table below.

Table 1. AR-Based flashcard prototype

No	Prototype Component	Page Design	Description
1.	Front Cover		1. Title example of the implementation of mutual cooperation 2. Image example of mutual cooperation in pratice 3. Image description
2.	Back Cover		1. QR code containing AR elements, accompanied bya song related to the image's theme 2. Scope of mutual cooperation application

Product Design Validation

After designing the product to be developed, the media will be tested by experts. The feasibility of the media is evaluated by media and material experts to determine if the media is effective for use. The assessment is presented using a Likert scale. Material and media experts fill out the questionnaire and provide suggestions for improvements to the media and content. The evaluation aspects used in the questionnaire are based on Arsyad (2020). Flashcards are considered a sufficiently effective medium to improve students' information literacy. Flashcards are enjoyable as they are equipped with various colors and attractive images, as stated by Philosophy & Harisanty, (2020) Each flashcard

created by the researcher has different colors and images that match the example of mutual cooperation in the surrounding environment.

The feasibility of the flashcards will be tested using formative sheets from material and media experts. The feasibility test aims to determine if the media developed is suitable for implementation in National Ideology Education, specifically the mutual cooperation topic in the surrounding environment. The results of material expert validation were 85.4%, and media expert validation was 90.2%. The validation results from both material and media experts indicate that the media is "highly feasible." The following is the recapitulation table of the material and media experts. The feasibility aspect of the material, with a maximum score of 48, received a score of 41, resulting in a percentage of 85.4%, which falls into the highly feasible category. The feasibility aspect of the media, with a maximum score of 92, received a score of 83, resulting in a percentage of 90.2%, which also falls into the highly feasible category. This aligns with the research by Basumatary & Maity, (2023) which states that AR media is highly feasible for use in learning and can enhance students' learning outcomes.

Figure 1. AR flashcard design - school environment

Figure 2. AR flashcard design - community environment

Figure 3. AR flashcard design - home environment

Design Revisions

Based on the validation from media and material experts, suggestions were made to ensure that the media designed by the researcher can be applied effectively and function properly. Media experts suggested adding 3D objects to the AR-based flashcards. The design revision includes the addition of 3D objects, as shown below:

The inclusion of 3D objects in the AR flashcards will deepen students' understanding of the lessons. This aligns with the research conducted by Ýbili et al. (2020), which states that there is a significant difference in students' understanding when 3D objects are included in AR.

Figure 4. AR flashcard design – nation and state environment

Product Trial (Small- Scale Classroom Trial)

In the product trial phase, the AR-based flashcards developed by the researcher will be tested in a small-classroom setting with 6 fifth-grade students from SDN Pandansari 01 Batang, consisting of 2 high-performing, 2 average, and 2 low- performing students. The media is considered effective if the average pretest and posttest scores, consisting of 25 questions, show significant improvement. Before the lesson, students were asked to complete a pretest, and after the lesson, they completed a posttest. The results of the application of the AR-based flashcards indicate a significant increase in student learning outcomes.

Small-Classroom Learning Outcome Recapitulation: 6 students were given pretest and posttest. The highest pretest score was 80, and the lowest was 52. The highest posttest score was 100, and the lowest was 88. The average pretest score was 66, and the average posttest score was 93.33, with a difference of 27.33 points.

The learning outcomes of students showed significant improvement. The average pretest score was 66, which increased to an average posttest score of 93.33. This improvement in learning outcomes shows that students understood the material well with the presence of AR-based flashcard media. This aligns with the research by Kaviyaraj & Uma, (2021) which states that AR offers interactions with digital content that create more interactive and engaging learning experiences.

The researcher also distributed a mutual cooperation dimension questionnaire to measure students' perceptions and the application of mutual cooperation values in the surrounding environment. This questionnaire contained several sub-elements of the mutual cooperation dimension and was administered to students before and after the lesson. The questionnaire consisted of 10 questions with a Likert scale (strongly agree, agree, disagree, strongly disagree).

The recap of the questionnaire on the dimension of mutual cooperation in small classes contains 6 sub-elements of mutual cooperation. The average score for the sub-element of cooperation before using AR was 54.17%, which increased to 100% afterward. The average communication score to achieve common goals before using AR was 43.3%, which rose to 97.9% after using it. The average score for positive interdependence before using AR was 58.33%, increasing to 95.83% afterward. The average score for social coordination was 45.8% before using AR, which increased to 91.7% after. The average score for responsiveness to the social environment before using AR was 54.2%, which rose to 93.8% afterward. The average social perception score before using AR was 52.1%, increasing to 97.9% after. The overall difference in the recap was 45.42%, with a high interpretation.

It can be concluded that there was an improvement in the implementation of mutual cooperation among students after using AR-based flashcard media. The achievement of student learning outcomes on the topic of mutual cooperation in the surrounding environment is closely related to students' perceptions and the implementation of mutual cooperation. The

research results on the dimension of mutual cooperation in students obtained an average percentage in the high category based on the results of the questionnaire that was distributed. The average response was "strongly agree," indicating that AR-based flashcard media can be considered successful in improving the dimension of mutual cooperation in students.

Based on the interviews I conducted after the teaching practice with the 5th-grade teacher and 3 student representatives, both the teacher and the students stated that the use of AR significantly enhanced the mutual cooperation scores. The teacher noted a significant increase in cooperation, communication, and other aspects such as social coordination. The students admitted that AR made the learning process more interactive and helped them better understand the concept of mutual cooperation. The increase of 45.42% in the high category proves that AR effectively strengthened mutual cooperation among 5th-grade students after the intervention.

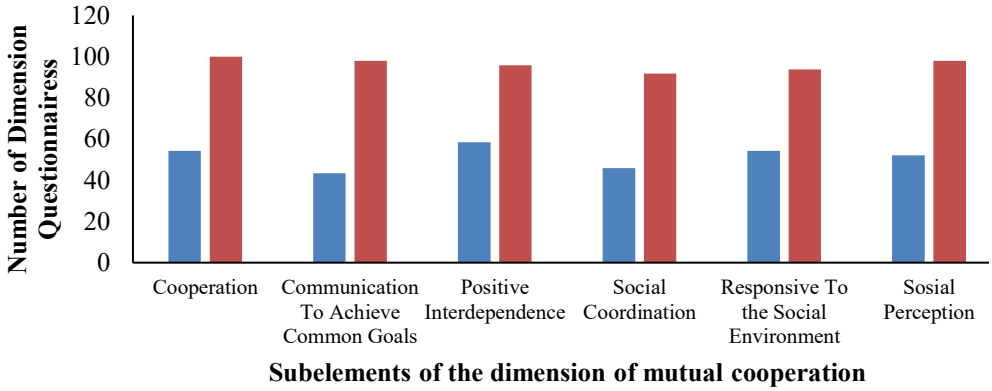


Figure 5. Recap of the mutual cooperation dimension questionnaire in small classes

Product Revision Stage

In the product revision stage, this research did not carry out product revisions, as based on the questionnaire responses from teachers and students, the results were already satisfactory.

Trial Use (Large Class Trial)

At the product trial stage, the AR-based flashcard media developed by the researcher was tested in a large class setting with 25 students from grade V at SDN Pandansari 01 Batang. The media can be considered effective if the average pretest and posttest scores, consisting of 25 questions, show significant improvement. Before the learning process, students were asked to complete the pretest, and after the lesson, they completed the posttest. The results after applying the AR-based flashcard media indicate that there was a significant improvement in student learning outcomes. A summary of the learning outcomes for the large class given to 25 students shows that in the pretest, the highest score was 76 and the lowest was 40. In the posttest, the highest score was 96 and the lowest was 76. The average pretest score was 56, and the average posttest score was 87.2, with a difference of 31.2.

Student learning outcomes showed a significant improvement. The average pretest score was 56, which increased to 87.2 in the posttest. This improvement indicates that students understood the material well with the use of AR-based flashcard media. This is consistent with the research by Kaviyaraj & Uma, (2021), which stated that AR offers interaction with digital content, creating a more interactive and engaging learning experience.

The researcher also distributed a mutual cooperation dimension questionnaire to assess the

extent of students' perceptions and the application of mutual cooperation values in their surroundings, which included several sub-elements of the mutual cooperation dimension. This questionnaire was given to students before and after the lesson, consisting of 10 questions with a Likert scale of 4 preferences (strongly agree, agree, disagree, strongly disagree).

The summary of the mutual cooperation dimension questionnaire in the large class includes 6 sub-elements of mutual cooperation. The average score for the cooperation sub- element before using AR was 50%, which increased to 100% afterward. The average communication score to achieve common goals before using AR was 52%, which increased to 98% afterward. The average positive interdependence score before using AR was 53%, which increased to 97% afterward. The average social coordination score before using AR was 53%, which increased to 96% afterward. The average responsiveness to the social environment score before using AR was 55%, which increased to 97% afterward. The average social perception score before using AR was 47%, which increased to 96% afterward. The total difference in the recap was 44%, with a high interpretation.

Based on these results, it can be concluded that there was an increase in the implementation of mutual cooperation among students after the use of AR-based flashcard media. The achievement of student learning outcomes on the topic of mutual cooperation in the surrounding environment is inseparable from students' perceptions and the implementation of mutual cooperation. The research results on the dimension of mutual cooperation in students obtained an average percentage in the high category based on the results of the distributed questionnaire. The average responses were "strongly agree," indicating AR-based flashcard media can be considered successful in enhancing the dimension of mutual cooperation in students.

Based on the interviews I conducted after the teaching practice with the 5th-grade teacher and 6 student representatives, both the teacher and the students stated that the use of AR significantly improved the mutual cooperation scores. The teacher noted extraordinary improvements in all aspects, from cooperation to communication, etc. The students admitted that AR made the learning experience more engaging and concrete, helping them to better understand the values of mutual cooperation. "Now we are more united in completing group projects," said one student. With a significant increase, AR proved to be very effective in fostering mutual cooperation in the class.

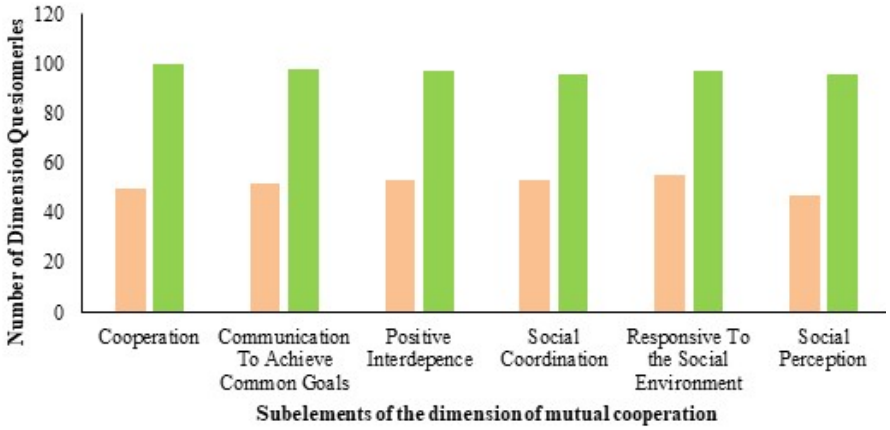


Figure 6. Recap of the mutual cooperation dimension questionnaire in large classes

The achievement of student learning outcomes in both small and large-scale learning through pretest and posttest questions underwent a normality test to assess whether the pretest and posttest results were normally distributed. Data is considered normally distributed if the significance level (p-values) is greater than 0.05 (p>0.05). This research used the Shapiro-Wilk method to measure normality. Based on the Shapiro-Wilk statistical test, the pretest and posttest data had a p-value of >0.05, indicating that the data were normally distributed. The results are presented in Table 2.

The next statistical test is the t-test to find significant differences between pretest and posttest scores. The data is considered significant

Table 2. Normality test

	Kolmogorov-Smirnov			Saphiro-Wilk		
	Statistic	**Df**	**Sig.**	**Statistic**	**Df**	**Sig.**
Pretest	.162	31	.037	.959	31	.268
Posttest	.183	31	.009	.943	31	.097

if the significance value (p-value) is less than or equal to 0.05 (p<0.05). The t-test result obtained a p-value of 0.000, which indicates a significant difference between the pretest and posttest results. This proves that the use of AR-based flashcard media in National Ideology Education lessons on mutual cooperation in the surrounding environment is effective in optimizing student learning outcomes. The results are presented in Table 3.

Table 3. Paired samples statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	**Pretest**	57.94	31	9.402	1.689
	Posttest	88.39	31	5.875	1.055

Table 4. Paired samples correlations

				Significance	
		N	**Correlation**	**One-Sides p**	**Two-Sided p**
Pair 1	**Pretest &Posttest**	31	.285	.060	.120

Table 5. Paired samples test

		Paired differences							
					95% confidence interval of the difference				
		Mean	**Std. Deviation**	**Std. Error Mean**	**Lowee**	**Upper**	**t**	**df**	**Sig. (2-tailed)**
Pair 1	Pretest & Posttest	-30.452	9.560	1.717	-33.958	-26.945	-17.736	30	<.001

The significance level in learning outcomes is calculated using the n-Gain test. Data can be significant if it obtains an interpretation greater than or equal to 0.70 (n-Gain d 0.70). The n-Gain analysis for this research obtained a score of 0.71, which falls into the high category. This score indicates a high increase in student learning outcomes. The n-Gain summary results show a pretest score of 61.00 and a posttest score of 90.27, with an average difference of 29.27. The average n-Gain score is 0.71, with a high criterion. The obtained n-Gain score is 71%.

This research has significant differences compared to previous studies on the use of AR-based flashcard media. The mutual cooperation dimension shows significant differences, proven by the results of the mutual cooperation dimension questionnaire given to students. The results show that the total average of 6 sub-elements of the mutual cooperation dimension before using AR in the small class was 50.42%, and in the large class, it was 53%. After using AR, this increased significantly to 96% in the small class and 97% in the large class. Student learning outcomes also show significant differences, proven by the results of the students' cognitive tests during the lesson. In the small class, the highest pretest score was 80, and the lowest was 52. The highest posttest score was 100, and the lowest was 88. The average pretest score was 66, and the average posttest score was 93.33. In the large class, the highest pretest score was 76, and the lowest was 40. The highest posttest score was 96, and the lowest was 76. The average pretest score was 56, and the average posttest score was 87.2. This proves that there was a significant difference after the use of AR-based flashcard media with the PBL model.

The use of AR-based flashcard media with the PBL model showed significant improvements. This aligns with research by Rusli et al. (2022), which stated that the application of AR provides a more enjoyable learning experience for elementary school students and improves their learning outcomes. Another study by Rahmawati et al. (2024) supports this, stating that mutual cooperation by applying the PBL model in elementary schools can improve student learning outcomes. The novelty of this research, which differentiates it from others, lies in the subject matter, research location, and focus. Other studies have used AR in science subjects, but this research develops AR for National Ideology Education on mutual cooperation in the surrounding environment. The research location is also different from other studies, and the focus is on developing AR-based flashcards as an innovative learning media that enhances mutual cooperation dimensions and student learning outcomes.

The practical implication of this research shows that the use of AR-based flashcards can enhance student engagement, understanding, and the application of mutual cooperation attitudes, so it is recommended that teachers integrate it into lessons. Schools should also provide technology training to teachers to create innovative learning media. Policymakers should allocate funds for the development of digital media, and developers should periodically update AR with relevant content. A limitation in this study was the challenge in designing AR-based flashcards using Assemblr Edu. The 3D objects supporting the material developed by the researcher were still limited, requiring more time to find suitable 3D objects.

Data analysis shows that the AR-based flashcard intervention caused a significant improvement in all sub- elements of mutual cooperation, both in small and large classes. The highest increase occurred in the cooperation sub-element, with a 45.83% increase in the small class and 50% in the large class. The communication sub-element for achieving common goals increased by 54.6% in the small class and 46% in the large class. The intervention effect is triggered by the interactive AR, which strengthens mutual cooperation, but the class size did not affect the results, as high results were achieved in both classes. Success depends on the teacher's

ability to integrate technology and the availability of supporting facilities.

The use of AR-based flashcards to improve mutual cooperation dimensions and student learning outcomes is influenced by several contextual factors, including students' background with technology skills and attitudes during the lesson, teachers' competence in integrating AR, the availability of school resources such as devices and network infrastructure, and the effectiveness of this media in providing innovative learning supported by parental involvement and school policies.

After completing all the stages of Borg and Gall, the researcher conducted an evaluation to measure the effectiveness and feasibility of the AR-based flashcard media. The collected data will be used to measure the effectiveness and feasibility of the media. The data collection results show that AR-based flashcard media is effective and feasible for use in National Ideology Education lessons on mutual cooperation in the surrounding environment. The use of AR-based flashcards has shown significant improvements in both student learning outcomes and the mutual cooperation dimension. Research by Buchner et al. (2022) also confirms that the application of AR can create a fun learning environment, increase student enthusiasm, and significantly improve student learning outcomes.

The researcher faced challenges in developing AR-based flashcards, such as the lack of some 3D elements in the Assemblr Edu application. The application of technology in education always encounters challenges, as supported by research conducted by B Berendt, (2020), who stated that there are several obstacles when attempting to integrate technology into education.

■ CONCLUSION

The product development of AR-assisted flashcard learning media is deemed highly feasible for implementation in National Ideology Education lessons, specifically the material on Mutual Cooperation in the Surrounding Environment. Students' understanding of mutual cooperation in the surrounding environment can be effectively learned through the presence of 3D objects in AR-based flashcard media. The feasibility of this media is demonstrated by expert validators' assessments, which categorize it as highly suitable. Both teachers and students show positive responses and great enthusiasm in applying the learning media developed by the researcher.

The research successfully developed an interactive AR- assisted learning media that is effective in enhancing the mutual cooperation dimension and learning outcomes in National Ideology Education, particularly in the material of Mutual Cooperation in the Surrounding Environment. There was a significant improvement in students' learning outcomes after using the AR media. The implementation of AR technology in the learning process of mutual cooperation has been proven to motivate students to learn, as evidenced by their enthusiasm and active involvement during the lesson, as well as the improved results from the mutual cooperation dimension questionnaire. This finding highlights the great potential of using AR in other subjects, thereby increasing the effectiveness of technology- based media in elementary education

For future research, it is recommended to explore the longterm impact of AR on students' ability to retain the knowledge acquired, considering the development of various fields of study. The feasibility of using AR should be examined on a larger scale, including the challenges related to access and technical implementation, so that educators can gain a deeper understanding of how to harness the advancements in technology for educational purposes.

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