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Development of Augmented Reality Assisted Interactive Multimedia on Human Visual Sense Material to Improve Learning Outcomes of Elementary School Students

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A B S T R A C T

This study aimed to describe development design, test the feasibility and effectiveness of AR assisted interactive multimedia on human visual sense material to improve learning outcomes of fifth grade students at SDN Kuningan 04 Semarang City. This research procedure used Research and Development (RnD) method with Borg and Gall development model. Data collection techniques involved test methods (pre-test and post-test) and non-test methods (observation, interviews, questionnaires, and documentation). Data analysis used normality test, t-test, and N-Gain test. This study presents the design AR assisted interactive multimedia developed using Canva and Assemblr Edu consists of menu, usage instructions, material including text, images, animations, videos, AR to strengthen visual media, evaluation (Quizizz), and games (wordwall). The feasibility of AR assisted interactive multimedia is shown by the assessment of material experts by 95% and media experts by 95%, highly feasible category. Supported by response questionnaire from teacher 100% and students 100%, highly feasible category. The average pre-test score was 65.6, the average post-test increased to 85.9. The N-gain test results an average value 0.6 medium category. The conclusion of this study shows that AR assisted interactive multimedia on human visual sense material was successfully developed, feasible and effective for improving learning outcomes.

1. Introduction

Education is a conscious and directed process, carried out both within and outside the school environment, with the aim of helping individuals develop their potential (Kurniawati & Koeswanti, 2020). Every individual has the right to quality and equitable education. The quality of education is closely related to a curriculum that aligns with the developments of the times and technology. The curriculum currently implemented in Indonesia is the Merdeka Curriculum, established through the Kepmendikbudristek Republik Indonesia No. 56 of 2022 as a refinement of the

previous curriculum. The Merdeka Curriculum includes Learning Outcomes, which are the learning competencies that students must achieve at the end of each phase, adjusted to the characteristics of each subject, including one of them, IPAS learning.

IPAS learning is interdisciplinary field integrating Natural Sciences (IPA) and Social Sciences (IPS). To optimally achieve the learning objectives of IPAS, it's necessary to implement ideal IPAS learning with students needs and creates a PAIKEM learning environment. PAIKEM stands for Active, Innovative, Creative, Effective, and Joyful Learning (Dharmawansa, 2019). PAIKEM encourages students to think actively, innovatively, and creatively, promoting effective and enjoyable learning (Afrih Lia et al., 2021). Science learning that encourages student involvement, innovatively presents media, creatively develops interesting learning methods, effectively achieves learning objectives, and creates a pleasant atmosphere. PAIKEM learning also enhances motivation, active participation, and students' communication and interaction skills (Made Bagiarta, 2021). IPAS learning doesn't focus on theory, but integrates relevant practicum activities to prove and understand essential concepts for stimulate critical and creative thinking.

IPAS learning includes concepts that are difficult observed directly, such as the human visual sense material in fifth grade of Phase C. This topic discusses the parts of the eye and the functions, including the lens, cornea, retina, and optic nerve, related the anatomy and mechanism of how the eye receiving light stimuli. The abstract and complex nature of this anatomy makes direct observation difficult. Therefore, interactive and effective learning media are required to present the visual organs in a concrete and engaging manner, thereby helping students grasp the material more deeply and comprehensively. Supported by Tetep et al., (2023) stated that IPAS learning is more engaging when presented through innovative, creative, and intelligent 3D real-time that offer new learning experiences..

Technological advances encourage the development of information technology, now widely utilized across various fields, including in the field of education. This development opens up opportunities to create a technology based learning environments through learning media that acts as a stimulus to arouse student interest and motivation in facilitating the delivery of material (Dzikrika et al., 2024). In the information era, media needs to be be designed according with developments, environmental conditions, expectations, and technology. One such innovation in technology based learning media is the use of AR-assisted interactive multimedia.

Multimedia is a combination of data, sound, video, audio, animation, graphics, text and audio (Marjuni & Harun, 2019) with interactive delivery in visualizing lesson content so that learning is more meaningful (D.P. Arimas et al., 2022). In IPAS learning, interactive multimedia plays an important role to facilitating the delivery of abstract material into concrete concepts through animated visualization supported by audio elements (Darman et al., 2021). Presenting material in interactive multimedia that is interesting, effective and efficient can help students achieve learning outcomes and improve good understanding (Syawaludin et al., 2019).

AR technology integrates virtual objects into real environment and adds relevant contextual information (Yunita et al., 2025). One platforms utilizing AR technology is Assemblr Edu (Agustin & Wardhani, 2023). Assemblr Edu is application developed to create interactive and engaging AR media using 3D visual content by combining available objects (Chairudin et al., 2023). Research by (Danti et al., 2023) shows that the use of AR media can have an influence on student learning outcomes in IPAS subjects. Implementation of Augmented Reality (AR) technology in learning can enhance students comprehension of the material, boost their engagement in the learning process, and offer a more contextual and interesting learning experience (Tasya'ah et al., 2025).

Based on pre-research data on November 11 2024, through observation, interviews, and questionnaires with teachers and fifth grade students at SDN Kuningan 04, Semarang City, several problems were identified in science learning. Teachers had not optimally utilized technology based instructional media used throughout the learning process. They only used SCI Media videos and PowerPoint slides containing text without images or animations.

Although videos and slides were used, the slides lacked engaging visuals due to limited teacher skills in developing exploratory multimedia, (D.P. Arimas et al., 2022) despite students being more interested in visuals with brief text explanations (Nurkhalimah et al., 2025). Additionally, there are limited props regarding the eye anatomy to support classroom learning. The media used was neither engaging and effective for students at the concrete operational stage, making learning boring, passive and reduces the enthusiasm students for learning.

Student learning outcomes based on the results of diagnostic cognitive assessments of fifth grade students on the human visual sense material are relatively low, involving 29 students (13 boys, 16 girls), showed that 65.5% (19 students) get scores below KKTP, and 34.5% (10 students) scores above KKTP. The KKTP of IPAS is 70. These results indicate less than optimal learning, previous research also obtained results that low achievement is linked to the limited use of audio-visual learning media (Windasari & Syofyan, 2019). Abdurrahman et al., (2020) emphasized that the implementation of learning media affects student interest and motivation. Praja & Andriani (2025) added that student learning outcomes can improve if given various stimuli, both visually and audio-visually.

Based on observations during IPAS learning, students had difficulty understanding the human visual sense material due to it's abstract nature, such as eye parts, functions, mechanisms of seeing, disorders, maintenance and treat eye health. At this cognitive development stage, students struggled to visualize and comprehend the interaction of these components. This aligns with (Adriani & Lazuardi, 2018) state that the abstractness of sensory system material causes students to rely on guessing rather than direct observation, leading to confusion, reduced interest, and lower learning outcomes.

The results of this study align with the research by Nabila et al., (2024) titled "Development of Interactive AR Multimedia 'TereDaman' Based on Problem-

Based Learning in Elementary Science Education." The study showed validation results from media, content, and language experts at 96.05%, 86.11%, and 87.5% respectively, all categorized as Very Good. Student trials one-to-one, small group, and field test resulted in 96.43%, 97.62%, and 96.43%, also in the Very Good category. In conclusion, the AR-based interactive multimedia is feasible and effective for teaching fifth-grade science. Another relevant research by Uno (2024) titled *"*Development of AR-Based Interactive Learning Media to Improve Science Concept Understanding*,"* reported an average pre-test score of 65 and post-test score of 85. This research demonstrates that the use of interactive AR-based learning media has been proven to enhance students conceptual understanding of science, as well as their motivation and engagement in the learning process.

Based on the identified problems, an alternative solution is needed to address the challenges faced by teachers and students through the use of engaging, effective, and practical technology based learning media. Therefore, the researcher aims to develop an innovative learning medium in the form of AR-assisted interactive multimedia. This development is expected to improve students cognitive abilities and learning outcomes on human visual sense material. The study aims to describe the design of AR-assisted interactive multimedia, test the feasibility, and evaluate its effectiveness in improving science learning outcomes of fifth grade students at SDN Kuningan 04 Semarang City.

2. Methodology

The type of research applied in this study is Research and Development (R&D). According to Borg and Gall in Sugiyono (2023), R&D is a process or method used to validate and develop product. This type of research was chosen because it provides clear stages in the planning, development, and testing of educational products. Sugiyono (2023) also states that the type of research R&D refers to a scientific method used to research, design, develop and test validate of developed product.

The development model used in this study for creating the AR assisted interactive multimedia was the Borg and Gall development model. This model emphasizes product validation and refinement through 10 stages, including: (1) Potential and Problems, (2) Data Collection, (3) Product Design, (4) Design Validation, (5) Design Revision, (6) Preliminary Testing, (7) Product Revision, (8) Usage Testing, (9) Product Revision, (10) Dissemination and Implementation. Upon receiving ethical approval, the research was implemented following these stages, illustrated in Figure 1.

This research was conducted at SDN Kuningan 04 Semarang City, the even semester of the 2024/2025 academic year. This study involved 26 fifth-grade students, 6 students were selected for testing based on cognitive ability categories (high, medium, low) and 20 students for large group usage testing.

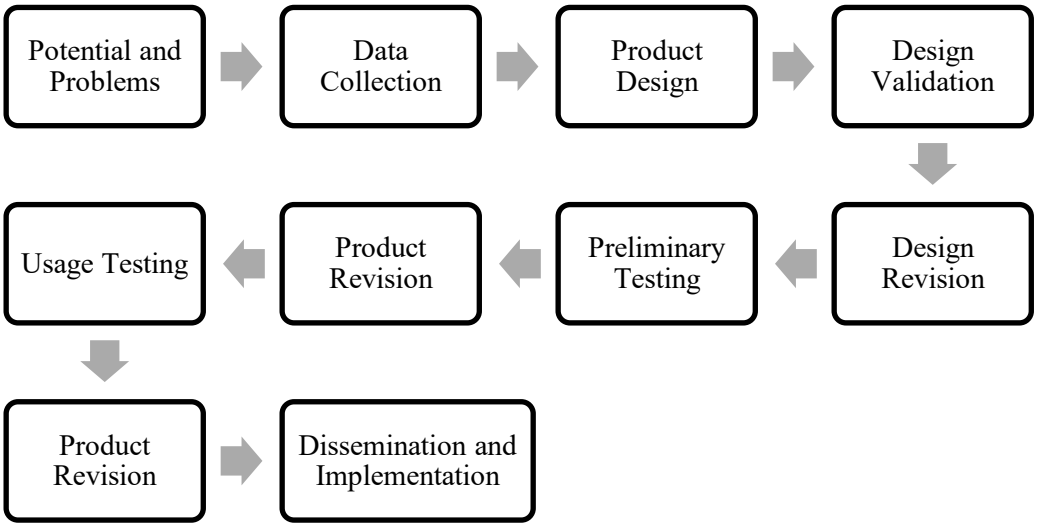


Figure 1. Steps of the Borg and Gall Model (Sugiyono, 2023)

The selection of subjects through purposive sampling technique, a sampling technique with certain considerations (Sugiyono, 2023) relevant to the research objectives. Data were collected through tests (pre-test and post-test) and non-tests (interviews, observation, questionnaires, and documentation). Data analysis techniques used normality test, T-test, and N-Gain test.

3. Results and Discussion

Development of AR-assisted Interactive Multimedia

The results of this study produced an AR-assisted interactive multimedia product developed for the human visual sense material for fifth-grade students at SDN Kuningan 4, Semarang City. These results of the study discuss: (1) the design of AR-assisted interactive multimedia development, (2) testing the feasibility, and (3) effectiveness of AR-assisted interactive multimedia to improve learning outcomes. The development design in this study used the Borg and Gall development model, described below:

Potential and Problems

Potential and problems aim to identify the potential, problems and needs of students. Potential is everything that is used or developed will have added value (Sugiyono, 2023). This research began by identifying potential and problems. The analysis was conducted through observation and documentation at SDN Kuningan 04 Semarang City. Based on observations and interviews with teacher, the identified potential includes the availability of projector/LCD, adequate internet access, chromebooks and school computer lab, also permission for students to use smartphones during learning activities. Problem are deviations between what is expected and what happens (Sugiyono, 2023) The problems identified in this study at SDN Kuningan 04 Semarang City are: (1) the teacher hasn’t been optimized in

using technology-based learning media that is interactive and less interesting for students, and there lack of visual aids or eye torsos to support the learning process in class; (2) low learning outcomes of fifth grade students at SDN Kuningan 04 Semarang City, seen from several students not meeting the KKTP standard based on the results of the cognitive diagnostic assessment in science on the material human visual sense, Topic B: Seeing Because of Light; (3) identification of more in-depth human visual senses material to improve understanding of abstract science concepts for students. Teachers and students require technology-based learning media such as interactive multimedia. AR media is introduced to address the limitations of teaching aids. Therefore, AR-assisted interactive multimedia is developed to support classroom learning, increase student interest, and simplify abstract concepts through visual, audio, text, video and animation. It is accessible via smartphones and chromebooks, expected to improve students learning outcomes at SDN Kuningan 04 Semarang City.

Data Collection

Data collection aims to collect information as a basis for product planning to address problems (Sugiyono, 2023). Researcher used teacher and student needs questionnaires to designing products tailored to learning conditions and needs. The analysis showed the need for AR-assisted interactive multimedia, as students had difficulty understanding IPAS on human visual sense material. The developed media must be engaging, colorful, include text, images, animation, video, audio, use simple language, align with learning outcomes and objectives, present 3D models of visual organs, include games and evaluation features.

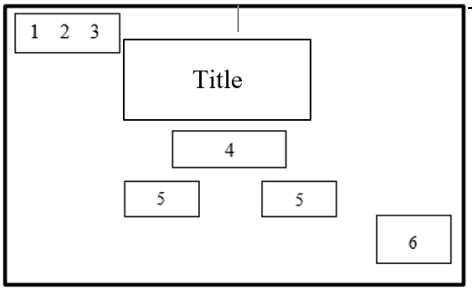
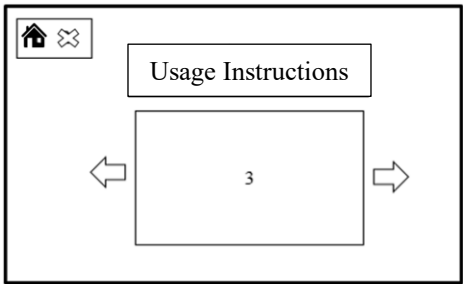
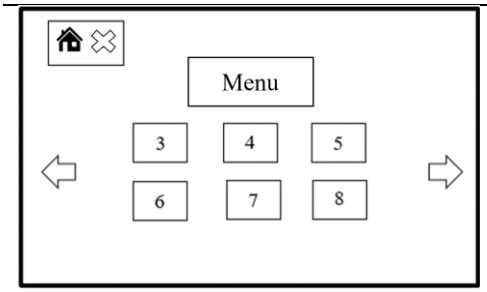
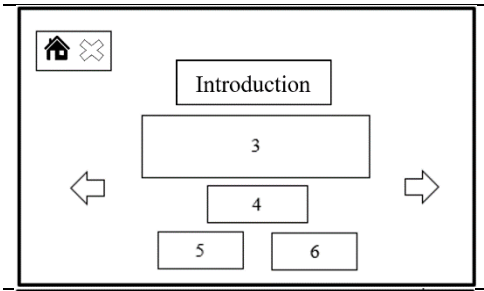
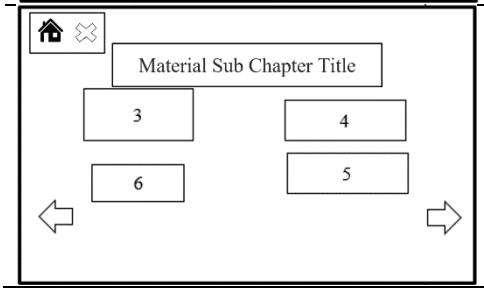
Product Design

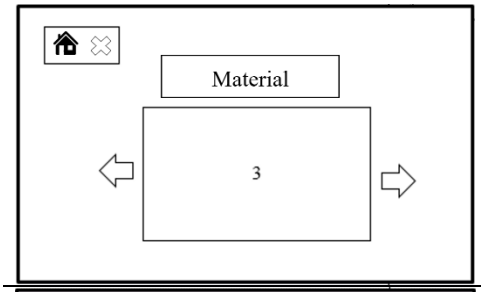
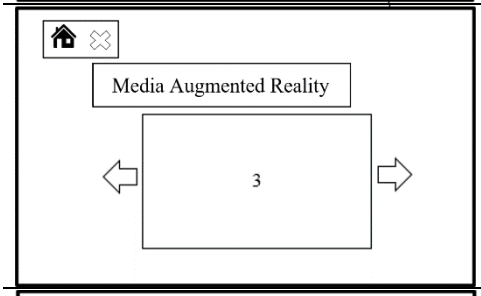
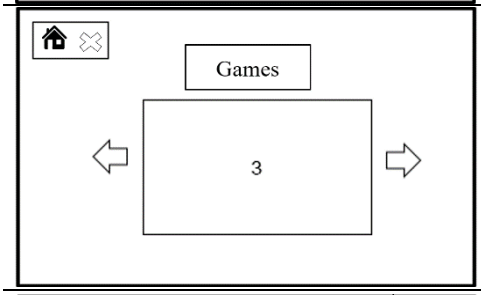
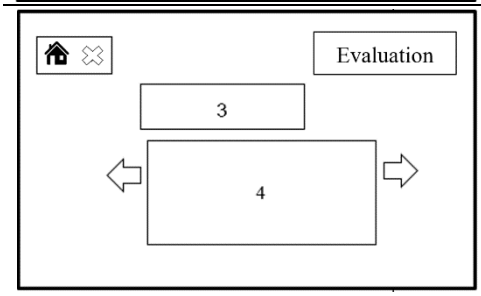
Product design involves planning the product to be developed based on identified problems and collected data. The design must be presented in pictures or charts to serve as a reference for evaluation and development (Sugiyono, 2023). In this stage, researcher created an initial concept and designed product prototype of AR-assisted interactive multimedia.

The design and development stages of the interactive multimedia include:

1. Product Design
   This stage involves designing the interactive multimedia workflow from start to finish. It begins with planning the multimedia concept, including learning objectives, target audience, platform, and multimedia type. The material is designed based on learning outcomes and objectives, covering topics such as parts and functions of the eye, the mechanism of vision, eye disorders, n how to care for and treatments. The next step involves designing visuals and multimedia elements, including engaging and interactive illustrations and animations. The final result is a new development product design (Sugiyono, 2023). Thus, the AR-assisted interactive multimedia design is the result of systematic design steps that result in a new product or prototype. At this stage, the researcher designed the AR-assisted interactive multimedia using Canva, described in Table 1.

Table 1. Desain Protoype

Layout	Information
	1. UNNES Logo 2. PGSD Study Program 3. Semarang State University 4. Start Icon 5. Developer and Academic Supervisor Identity 6. For (SD/MI), Grade, Phase, Curriculum
	3. Usage Instructions: contains information on how to use the application
	3. Introduction 4. Usage Instructions 5. Learning Materials 6. Evaluation 7. References 8. Developer Profile
	3. Introduction: contains information including subject, phase, grade, chapter/topic, and content 4. Learning Outcomes 5. Learning Objective 1 6. Learning Objective 2
	3. Learning Session 1 / 2 4. Sub-topic of Material 1 5. Sub-topic of Material 2 6. Educational Game

	3. Content Explanation Accompanied by Relevant Images, Animations, or Videos
	3. Media *Augmented Reality*
	3. Display / Link to Games via Wordwall
	3. Instructions for Completing the Evaluation via Quizizz 4. Display / Link to Evaluation via Quizizz

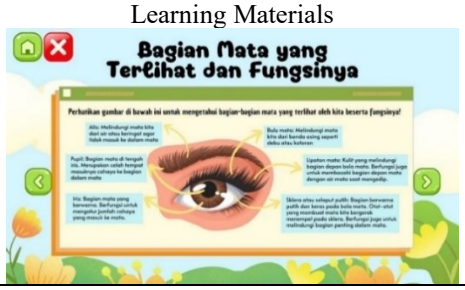
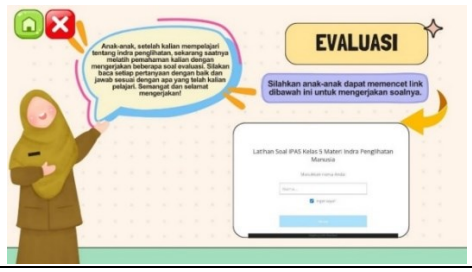
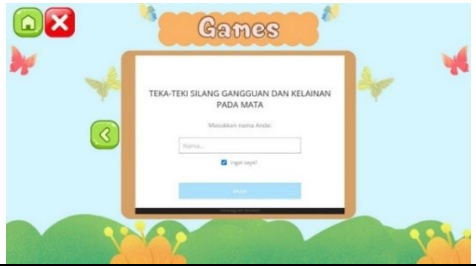
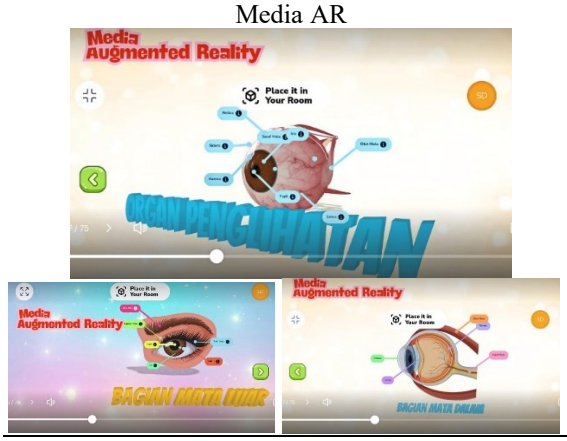
The design phase resulted in a developed product. Researchers used Canva application to design and finalize the product. Canva presents learning materials in a practical and user-friendly to improve students ability understand learning material (Lutfiani & Andriani, 2025). Additionally, researchers also used the Assemblr Edu application to integrate 3D objects of the human visual sensory organs into the media. Assemblr Edu is an educational tool employed by teachers and students to present Augmented Reality content through engaging and realistic 3D images and animations (Agustin & Wardhani, 2023), making it effective in improving students learning outcomes.

The final result at this stage is newly designed product with complete specifications (Sugiyono, 2023), namely AR-assisted interactive multimedia as learning media has various features, such as the main page, main menu, introduction containing learning outcomes and objectives, concept maps, usage instructions, material consisting of text, sound, images, animations, videos and songs related to the

material, AR media, evaluations, and games, so the learning process is optimal and learning objectives are achieved. The following is the display of AR-assisted interactive multimedia.

Table 2. AR assisted interactive multimedia design

Design	Description
Main Page	The main page contains material identification, class and developer identity.
Menu	Menu contains an introduction, usage instruction, materials, evaluation, bibliography, and developer identity.
Introduction	Page introduction contains the subject, phase/class, chapter/topic, material, outcomes and learning objectives on human visual sense material.
Material Concept Map	The material concept map contains sub-materials for each lesson • Lesson 1: parts of the eye and their functions, the mechanism of the visual process. • Lesson II : eye disorders and abnormalities, eye care and treatment.
Video and Somgs	Page video and song related to the material in each subtopic.

Learning Materials 	Learning material page contains the title, illustrations, and content explanations.
Evalution 	Evaluation page contains multiple-choice questions via Quizizz, completed individually using each device, the results immediately displayed as feedback.
Games 	Games page contains educational games such as crosswords, matching pictures through Wordwall. Games are accessed through links and aim to enhance participation and reinforce understanding
Media AR 	AR page presents 3D models of eye parts, allowing observation of eye structures from various angles in real environment. AR media clarifies the anatomy and functions of the eye in a concrete, engaging, and encourages active student involvement.

Design Validation

The purpose of product design validation is conducted to determine the feasibility of the developed product through subject matter experts and media experts evaluation using a validation instrument (Waruwu, 2024). The evaluation results are very important in assessing the feasibility of the product developed. The design validation uses a questionnaire as a instrument to determine the level of validity of AR-assisted interactive multimedia from subject matter experts and media experts. Researcher receive scores, suggestions, and feedback from both of validators serve as references for refining the product. The validated interactive multimedia has

been found to be highly feasible for use in the learning process. The validation results are used as improvement materials to perfect the developed product (Andayani & Jakob, 2024).

Design Revision

Stage design revision, the researcher revises the product based on the validators feedback to ensure it is suitable for testing (Sugiyono, 2023). The revision is conducted to correct identified weaknesses and enhance the previously assessed product (Permata et al., 2022). The product was revised based on input from the subject matter expert. Revisions included modifying the introductory activity and adding direct observation of the eye to connected the material with a guiding question in the first syntax of the learning activity. For example, observing a classmate's eyes by paying close attention to the friend's eyes, followed by questions: "Have you ever observed your classmate's eyes? Are there any differences between your eyes and theirs? Do you have the same eye color as your friend?" These questions are intended to stimulate discussion on the uniqueness and diversity of human physical characteristics, particularly the eyes.

Preliminary Testing

Products that suitable for use must be tested to determine the level of effectiveness (Waruwu, 2024). The researcher conducted a small-group trial to identify initial problem in using AR-assisted interactive multimedia. The trial involved six fifth grade students at SDN Kuningan 04 Semarang City, selected based on their cognitive levels, consisting of two highly proficient students, two proficient students, and two low proficient students. The pretest was given before the trial, followed by a posttest. Pre-tests establish students baseline knowledge prior to instruction, while post-tests measure learning gains after instruction. At the end, teacher and student response questionnaires were distributed to gather suggestions before conducting a large-group trial.

Product Revision

This stage involves revising the initial product based on the results of the small-group trial (Waruwu, 2024). After conducting the product preliminary testing, qualitative information is obtained and the product will be improved based on the assessment teacher and students responses questionnaires. The results of the analysis responses questionnaires of teacher and student in the small group test found no weaknesses. Therefore, the product can be directly applied to large groups.

Usage Testing

The stage usage testing, the revised product was tested on a large group. The researcher conducted a trial with 20 fifth grade students at SDN Kuningan 04 Semarang City consisting of 13 female students and 24 male students. In this stage, students are divided into 5 groups and prepare smartphones according to the number of students to access AR-assisted interactive multimedia. The usage testing was

conducted on one class using written tests (pretest and post-test). This stage aimed to determine whether the AR-assisted interactive multimedia developed by the researcher effectively supported IPAS learning on human visual sense material. The usage testing aims to compare learning conditions before and after using the new system (Sugiyono, 2023).

Final Product Revision

The final product revision stage is the refinement of the developed product as the final step before mass production (Torang Siregar, 2023). The final product revision is based on the teacher and student response questionnaires during the large group trial. The teacher and student response questionnaires distributed by the researcher during the large group trial. The results of the analysis of student and teacher response questionnaires obtained a score of 100% from both teachers and students.

Dissemination and Implementation

This stage involves the dissemination of the product or model to individuals, groups, or systems (Waruwu, 2024). The primary goal of this stage is to evaluate the practicality and broader applicability of the developed product in learning environments. In this study, the process reached the mass production stage, which included sharing the link to the AR-assisted interactive multimedia online with teachers and all fifth-grade students who served as test subjects for media use. This stage aimed to observe how well the product could be accessed, implemented, and accepted in learning.

Feasibility of AR-assisted Interactive Multimedia

The feasibility of AR-assisted interactive multimedia on human visual senses is determined based on the feasibility test results from media expert and material expert validators. In addition, fifth grade teachers and students at SDN Kuningan 04 Semarang City conducted a feasibility assessment through a questionnaire. This assessment aims to determine whether the developed product meets the criteria, is feasible, and can be tested in learning. The validation results by the material expert and media expert are presented in Table 3.

Table 3. Results of Validation by Material Experts and Media Experts

Validator	Assessment Percentage (%)	Criteria
Material Expert	95%	Highly Feasible
Media Expert	95%	Highly Feasible

Based on Table 3, the validity test showed that the material expert and media expert each gave a feasibility score of 95%, categorized as highly feasible. The assessment used a Likert-scale questionnaire ranging from 1 (feasible) to 4 (highly feasible). Widaraeni & Vivianti (2021), also showed similar results, rated as highly feasible. The media expert validation questionnaire consisted of 16 questions with a total score of 64, covering three main aspects: content quality and objectives,

construction, and technical/display (Surjono 2017). The technical/display aspect scored highest (45.9%) because it was considered optimal, easy to operate on various devices such as laptops and smartphones, attractive design. Its interactive features also supported active student engagement.

The content expert validation questionnaire consisted of 20 questions with a total score of 80, assessing five aspects: suitability for learning objectives and outcomes, student characteristics and developmental level, support for content and presentation, comprehension stimulation, and accuracy in supporting factual, conceptual, principles or generalizations.. The aspect of content and presentation support received the highest percentage (35%), the presentation of human visual sense material using AR was considered effective in clarifying the material and encouraging active student participation.

Table 4. Teacher and Student Response Questionnaire Results

Response	Assessment Percentage (%)	Criteria
Teacher	100%	Highly Feasible
Students	100%	Highly Feasible

Table 4 presents the percentage of teacher and student responses. Teacher responses scored 100%, and student responses also scored 100%, both falling into the highly feasible category. Based on the validity results from material experts, media experts, teacher and student responses, it can be concluded that the AR-assisted interactive multimedia is highly feasible for use in learning.

Effectiveness of AR-Assisted Interactive Multimedia

The effectiveness of AR-assisted interactive multimedia on human visual sense material was evaluated through analysis of students learning outcomes based on pretest and post-test scores. Pre-test scores were obtained from questions answered by students before using the AR-assisted interactive multimedia, while the post-test scores were obtained from questions answered after the learning process. The results of the pretest and post-test assessments are presented in Table 5.

Table 5. Pretest and Post-test Results

Aspect	Pre-test Score	Post-test Score
Average	65.6	85.9
Maximum Score	76	100
Minimum Score	52	72

Based on Table 5, the average learning outcomes increased by 20.3 points, from the pre-test average of 65.6 to the post-test average of 85.9. This data indicates a significant improvement in learning outcomes, consistent with previous studies that showed significant increase in pretest and post-test scores through the use of AR-assisted interactive multimedia. Data analysis was conducted using SPSS 26, where researcher performed a normality test, paired sample t-test, and N-Gain test on students pretest and post-test scores.

The normality test was conducted to determine whether the data were normally distributed. This study used SPSS 26 software with the Shapiro-Wilk test. The of the normality test for pretest and post-test scores are presented in Table 6.

Table 6. Pre-test and Post-test Data Normality Test Results

Shapiro-Wilk	Significance Value (Sig.)	Kategori
Pretest	.281	Normal
Posttest	.136	Normal

The normality test criteria state that the data are normally distributed if the Sig. value is greater than 0.05. Conversely, if the Sig. value is less than 0.05, the data are not normally distributed. Table 6 shows the normality test results for pretest and post-test data. According to the table, the Sig. value for the pretest data is 0.281 (>0.05) and for the post-test data is 0.136 (>0.05). These results indicate that both don't deviate significantly from the normal distribution. Therefore, the normality assumption for parametric testing is met. Since both values are greater than 0.05, it can be concluded that the pretest and post-test data are normally distributed.

T-test can be conducted if the normality test shows that the data are normally distributed. Paired Sample T-test was conducted using SPSS 26 to assess the effectiveness of AR-assisted interactive multimedia. The t-test results are presented in Table 7.

Table 7. Paired Sample T-test Results

Treatment	N	Mean	T	Sig. (2-tailed)
Pretest	20	65,6	-20.30000	<0.000
Posttest	20	85,9		

The criteria for the paired sample t-test are as follows: if the Sig. (2-tailed) value is greater than 0.05, there is no significant difference between the pretest and post-test results. Conversely, if the Sig. (2-tailed) is less than 0.05, there is a significant difference. Based on Table 7, the Sig. (2-tailed) value is 0.000, which is less than 0.05. Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted. This indicates a significant difference between the pretest and post-test data. It can be concluded that there is a significant difference in learning outcomes before and after the use of AR-assisted interactive multimedia on the human visual sense material.

In addition, the N-Gain test was conducted to measure the average increase in pretest and post-test scores. In this study, the N-Gain test was conducted using SPSS 26, and the results are presented in Table 8.

Tabel 8. N-Gain Test Results

Treatment	Aspect	N-Gain	Criteria
Pre-test	65.6	.6021	Medium
Post-test	85.9		

Based on Table 8, the N-Gain test results show that the learning outcomes of fifth grade students at SDN Kuningan 04 improved after using AR-assisted interactive multimedia. The average N-Gain score reached 0.6021, categorized as medium. This indicates a significant improvement in students conceptual understanding. It suggests that AR-assisted interactive multimedia is effective in improving students learning outcomes on human visual sense material. The increase in average learning outcomes during the usage testing of the AR-assisted interactive multimedia is presented in Figure 2 below.

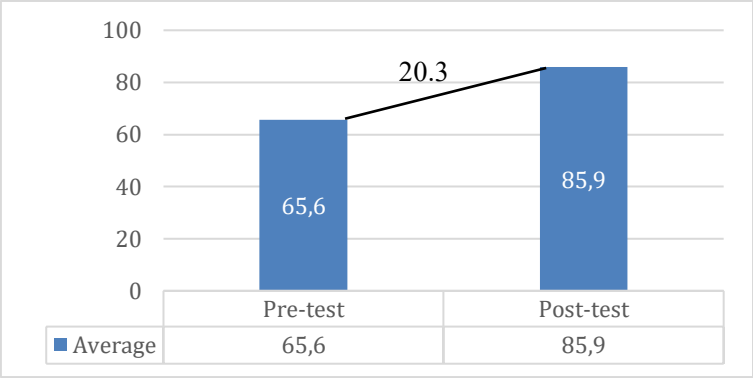


Figure 2. Pre-test and Post-test Resultes of Fifth Grade Students at SDN Kuningan 04 Semarang City

The average increase between pre-test and post-test scores in the large group trial was 20.3. Student scores fell into three categories: highly proficient (9 students), proficient (6 students), and less proficient (5 students), due to varying levels of understanding and ability. The moderate N-Gain score was influenced by several factors, including students readiness before learning covering physical and psychological conditions, material needs (Nainggolan & Sirait, 2024), and the ability to respond and interact during instruction. In addition, upper-grade students were allowed to use technological devices such as smartphones during learning. Proper and contextual use of technology enabled students to be more skilled and independent in exploring material through interactive multimedia. These factors are interconnected and contribute to achievement of learning objectives effectively.

AR-assisted interactive multimedia is adapted to various student learning styles visual, auditory, and kinesthetic facilitating the learning process (Jordy et al., 2022). Visual learners benefit from text, images, animations, and AR media using Assemblr Edu, which presents 3D models of eye parts and their functions. Auditory learners are supported through voice-based explanations and instructional videos accessible repeatedly. Kinesthetic learners are actively engaged through direct observation activities. A pleasant, safe, and engaging learning environment can enhance students interest and concentration, thereby contributing to improved learning outcomes (Arianti, 2017). This positive environment enables students to understand complex material more effectively and retain knowledge longer. Based on these factors, it can be concluded that AR-assisted interactive multimedia on human visual sense material is an effective media to improving learning outcomes of fifth grade students at SDN Kuningan 04 Semarang City.

4. Conclusion

Based on the problem identification above, this study concludes that the design of AR-assisted interactive multimedia using Canva to provide the design and Assemblr Edu to present the Augmented Reality consists of menus, usage instructions, material including text, images, animations and videos, AR to strengthen visual media, evaluation (Quizizz), and games (wordwall). The feasibility of AR assisted interactive multimedia is shown by the assessment of material experts and media experts, also supported by response questionnaire from teacher and students obtaining highly feasible category. The effectiveness of AR-assisted interactive multimedia demonstrated through the improvement in pre-test and post-test scores. This is supported by the t-test results, which indicate a significant difference before and after using the product, and the N-Gain test results obtaining medium category. Thus, AR-assisted interactive multimedia on human visual sense material was successfully developed, feasible and effective to improving the learning outcomes of fifth grade students at SDN Kuningan 04 Semarang City. The researcher suggested that future researchers are encouraged to focus on other essential IPAS concepts and explore lighter technology alternatives to Assemblr Edu.

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