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Monopoly Board Game as Augmented Reality-Based Interactive Learning Media for Improvement of Cognitive, Communication, Collaboration of Students Sdn 4 Rejoyoso Bantur Malang

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ABSTRACT

Augmented reality-based interactive learning media improve cognitive learning outcomes, communication, and student collaboration. The research design uses a quantitative approach with several stages, including the pre-research stage, which contains research on materials and the manufacture of learning media, the research stage, which contains the application of learning tools, and the post-research stage, namely the analysis of the data that has been collected. The research data source was conducted on 36 fifth grade students at SDN 4 Rejoyoso, who were divided into two groups: the treatment group and the control group. The results of the cognitive scores obtained in the treatment group through the N-gain score test, with an average of 80.14, are included in the effective category. The results of the unpaired t test yielded a Sig (2-tailed) value of 0.000 on communication and collaboration skills, showing that the MONOPOLY media had an effect on improving the students' social and collaborative skills, which are important affective and interpersonal competencies. It can be concluded that the MONOPOLY board learning media, which combines a physical board game with an augmented reality (AR) mobile application accessible via students' smartphones, has a positive effect on improving the cognitive learning outcomes, communication skills, and collaboration abilities of fifth-grade students at SDN 4 Rejoyoso Bantur Malang.

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1. INTRODUCTION

Education remains a strategic sector in Indonesia that demands continuous attention, particularly in enhancing learning quality and equitable access. Despite multiple policy reforms, Indonesian students continue to perform below international benchmarks. The 2018 Programme for International Student Assessment (PISA) indicated that Indonesian students scored significantly lower than the OECD average in reading, mathematics, and science. One concerning issue is the high repetition rate, reaching 16%, which is markedly above the global average of 5% (Jayanti & Susantini, 2021). Furthermore, the proportion of low-achieving students remains substantial, indicating the need for innovative, student-centered instructional models. These challenges underscore the importance of integrating interactive, technology-based learning media to foster cognitive engagement, communication skills, and collaboration among primary school students. Apart from that, according to President Jokowi, greater efforts are also needed to reduce the number of low achieving students. In 2030, he targets 15 to 20 percent to overcome this (Falah, 2021). On the other hand, every educator who should have the main task of teaching in the classroom is diverted to do administrative work. This causes misconceptions in learning.

One subject that has many misconceptions in elementary schools is science. This misconception can become a serious problem if it is not corrected immediately, because a mistake in one basic concept can lead a student to continuous mistakes. The existence of this misconception will hinder the process of acceptance and

assimilation of new knowledge by students (Pradana & Uthman, 2023). Animal organ systems are a key topic in elementary science that often give rise to student misconceptions and tend to be less engaging when taught through traditional methods. Mastery of this material is crucial because it serves as the foundation for understanding animal physiology and lays the groundwork for scientific thinking and reasoning skills that students will build upon in higher levels of biology education. According to (Aziz & Akram, 2022), animal organ system material contains a lot of reading with examples of images that are less attractive to students. This causes students to be less interested in learning and reading. The main cause of this is the material which is very complex where to memorize the organs involved in various organ systems such as the digestive system, respiratory system, circulatory system, and locomotion in each "class" of animals is not easy.

In addition, based on research conducted (Harefa et al., 2023) as many as 61.54% of students score below the KKM in science subjects. There are also other factors, namely the use of learning media in classes that are less attractive. So far, the learning media used by teachers are textbooks, PPT media, and videos from the YouTube platform or the like. In this case, learning media is needed that can interact directly with students so that students can build concepts and be interested in the material being taught (Daryanes et al., 2023). In addition, this is also due to the low level of collaboration and communication skills of elementary school students. Reporting from research (Angganing et al., 2022),communication and collaboration skills are two interrelated factors in classroom learning to determine the level of student understanding and also as boosters in increasing student understanding. This is because these two skills can link one student with another student to mutually understand the material they are studying (Parapat & Berlien, 2021).

One of the elementary schools in Indonesia is SD Negeri Rejoyoso 4 Bantur. This school is located in Bantur District, Malang Regency. Based on the results of our direct observations in Class V SD Negeri Rejoyoso 4 Bantur Malang, students spend more time telling stories and not completing assignments given by the teacher. Group work is usually only done by one or two students and most students do not understand what needs to be done, whereas from the results of group learning only 40% of the number of students are able to achieve above the KKM. In addition, the majority of Class V students have a low level of communication skills. This is because they are afraid of making mistakes when they want to ask about material or when they want to raise an idea.

Based on the case above, a monopoly game-based learning media was developed that could attract students' interest in learning animal organ system material. Until now, monopoly games are still in great demand by elementary school-age children and are very busy being played online and offline. Over time, the development of digital technology is developing very rapidly. This affects the games played by children also through their respective gadgets. Therefore, this monopoly game-based learning media is in the form of a hard file with explanations applied to the augmented reality (AR) system on each student's gadget so that it can be accessed.

Augmented reality (AR) learning media based on the monopoly game with material on animal organ systems. This game has a feature in the form of a barcode to make it easier for users to use augmented reality (AR) technology. It can realize animal characters as real as possible and expand the explanation of the organ systems of each animal so that children can learn about the world of animals in an easy and fun way. This game was developed not only as entertainment, but also as a learning companion for children. In accordance with research (Wijaya et al., 2021) that the monopoly game can be used as a learning companion for children to make it more fun, so as to increase children's interest in playing while learning. Based on this, a study entitled "The Effect of ANIMOPOLI as an Augmented Reality-based Interactive Learning Media on Improving Cognitive and Collaboration Skills of Students of SD Rejoyoso 04 Bantur Malang" needs to be carried out.

2. RESEARCH METHOD

This study uses a quantitative approach with data obtained in the form of numerical data. The numerical data obtained in this study are in the form of cognitive abilities, collaboration skills, and communication skills. Data was taken in the experimental class and control class so that the type of research used was a Quasi experiment. Quasi experiment is a type of research that is used to determine the impact of giving certain treatments. Data collection was carried out at SDN Negeri 4 Rejoyoso with a population of class V students and a sample of 36 students. The class was divided into two groups in the form of a treatment group totaling 18 students and a control group of around 18 students through purposive sampling with ability criteria based on previous student value data. The treatment group was given treatment through learning by applying learning media, while the control group received instruction through the conventional lecture method, using the same textbook and teacher explanations without the use of the ANIMOPOLI media. Students in the control group also participated in classroom discussions and group activities as usual but did not interact with the augmented reality or monopoly-based game media. This design ensured that any observed differences in outcomes could be attributed specifically to the integration of ANIMOPOLI in the experimental group, which can be seen in Figure 1.

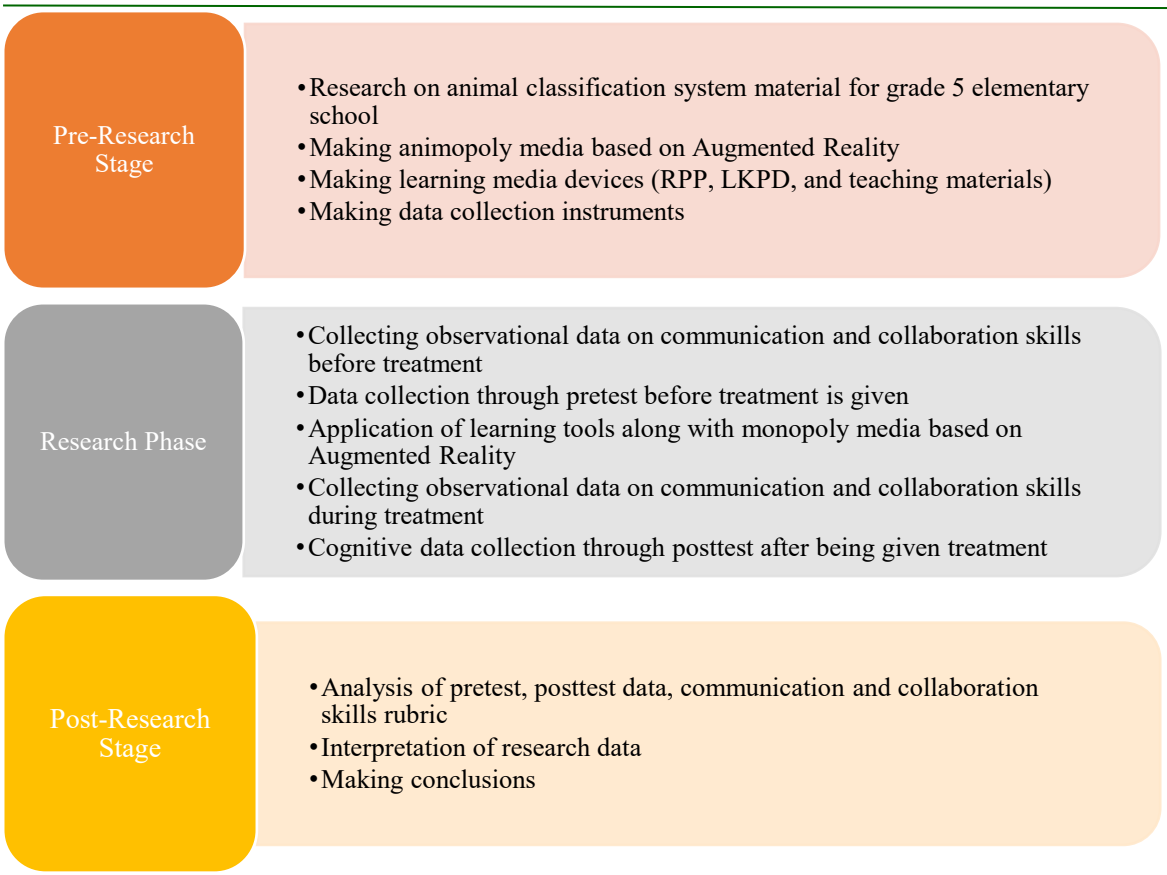

Figure 1. Research Procedure

The initial step of this research is in the form of research on the material and the creation of learning media that will be used. Material research is carried out to get a summary of the material that will be integrated into learning media. Making learning media is done through media planning and design. Augmented Reality design also created and integrated on the media. Learning tools that use media that have been developed are made in the form of Learning Implementation Plans (RPP), Student Worksheets (LKPD), and assessment instruments. Making learning tools is done to expedite the application of learning and data collection. Implementation was then carried out in the treatment class and control class according to the research plan.

Research data were collected using pretest and posttest instruments to assess students' cognitive achievement, and structured observation checklists combined with a communication and collaboration skills rubric to measure social competencies. The cognitive test items were adapted from the existing elementary science curriculum and reviewed by two subject matter experts to ensure content validity. The communication and collaboration skills instruments were developed based on established indicators adapted from Angganing et al. (2022) and Parapat & Berlien (2021). The rubric consisted of clear performance descriptors rated on a Likert scale.

To ensure validity, the instruments underwent expert judgment by three elementary science education lecturers and were revised accordingly. A pilot test was conducted with a similar group of fifth-grade students (N = 20) to test item clarity and appropriateness. Reliability was verified using Cronbach's Alpha, yielding coefficients of 0.82 for communication skills and 0.79 for collaboration skills, indicating acceptable internal consistency. Data were collected before (pretest) and after (posttest) the treatment in both groups to allow accurate comparison of learning gains. The collected data were analyzed using appropriate statistical tests as described below. The data obtained was analyzed for homogeneity test and normal distribution test to determine the nature of the data obtained as a prerequisite for parametric statistical tests. Paired t-test is used as a parametric statistical test differentiating two means when the data meets the prerequisites. The non- parametric Wilcoxon Signed Rank Test is used when the data does not meet one of the prerequisites for the parametric test. The effectiveness of learning with media that has been developed can be determined through the N-Gain test on pretest-posttest data (Triyono et al., 2024).

N-gain= (Posttest Score-Pretest Score)/(Maximum Score-Pretest Score) ×100

The results of the N-gain analysis are interpreted with four criteria, namely ineffective (less than 40), less effective (40 - 55), quite effective (56 - 75), and effective (more than 76).

3. RESULT AND DISCUSSION

The application of MONOPOLY media based on Augmented reality can improve students' cognitive abilities in classifying 5 animal classes. This is evidenced by the application of MONOPOLY media to the treatment class which shows an N-gain score test value with an average of around 80.14 in the effective category. This value is greater than the average N-gain score in the control class using the lecture method, which is around 63.77 in the fairly effective category, which can be seen in Figure 2.

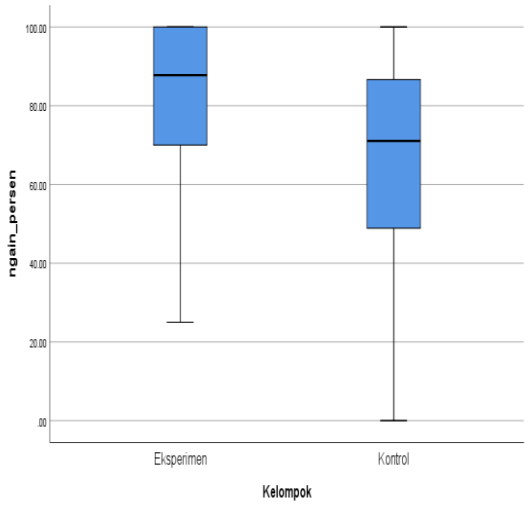

Figure 2. Results of analysis of N-gain score pretest and posttest

The application of the media also has an influence on cognitive improvement in students. The results of the unpaired t test yielded a Sig (2-tailed) value of 0.024 with a tcount (+) of 2.367. The application of a treatment has an effect when the Sig (2-tailed) value < 5% significance level and the tcount (+) > ttable or the tcount (-) <ttable. The Sig (2-tailed) value of applying Animopoly is 0.024 <0.05 and the tcount (+) is 2.367 > 1.691. Based on this analysis, H1 is accepted and Ho is rejected, so it can be concluded that Animopoly has an effect on the cognitive development of fifth grade students at SD N Rejoyoso 4. For example, (Wijaya et al., 2021) found that incorporating games into probability learning could increase students' interest and conceptual grasp. Similarly, (Edison & Aman, 2024) reported that monopoly game media outperformed pop-up books in improving junior high school students' cognitive scores in ASEAN social studies.

An increase also occurred in the psychomotor domain of students through monopoly learning. Measurable psychomotor skills are communication and collaboration skills. The results of the unpaired t test yielded a Sig (2-tailed) value of 0.000 on communication and collaboration skills. The significance value is less than 0.05, indicating that the monopoly media applied has an effect on improving the psychomotor skills of fifth grade students at SDN Rejoyoso 4. The positive effect on communication and collaboration skills observed in this study also aligns with findings by (Angganing et al., 2022), who emphasized that active classroom interaction can significantly foster students' communication competencies. Furthermore, the improvement in collaboration skills supports (Rahma & Asih's, 2024) results, which showed that joyful learning models and game-based activities encourage students to work together more effectively and reduce passive behavior during group tasks.

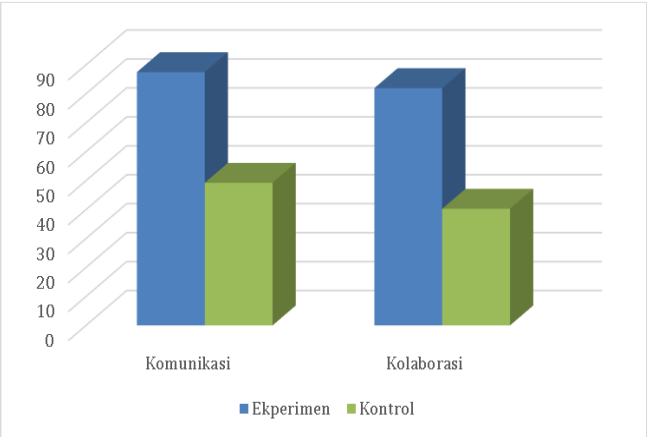

Figure 3. Learning Outcomes of Collaboration and Communication Skills after Treatment

The application of ANIMOPOLI media which is a monopoly game-based learning media also has significant results in terms of increasing students' collaboration skills at the elementary school level. Improving collaboration skills using ANIMOPOLY media is considered very effective. This is in accordance with research (Blasco et al., 2021), which says that students aged 7 to 12 years have an interest in learning which must be accompanied by playing. Learning using the lecture method is very unattractive and makes students less motivated. Therefore, we need a learning media that can increase student learning motivation which in turn can also affect the improvement of student collaboration skills.

The application of monopoly in learning class classification of vertebrate animals has an influence on student learning outcomes. Students experience a significant increase in learning compared to lecture learning. Several previous studies have also shown effective cognitive enhancement by implementing monopoly games in learning. The results of research at SD N Negeri Sumput Sidoarjo show effective cognitive improvement through learning with monopoly media (Edison & Aman, 2024). Monopoly can also add new knowledge, such as dental and oral health, to elementary school students effectively (Razakek et al., 2024).

The monopoly learning media that is applied also increases student learning outcomes in the affective domain. The increase occurred in students' collaboration and communication skills. Both of these skills increased due to the interaction between students in playing monopoly. The application of monopoly as a learning medium also makes students more enthusiastic about participating in learning (Rahma & Asih, 2024). According to (Onu et al., 2024), learning by using games offers several advantages, including: (1) games are fun and increase students' enthusiasm; (2) games encourage active participation, as seen in how students engage with the learning tasks; (3) games foster social interaction, since MONOPOLY, as a multiplayer game, naturally promotes student interaction within groups; and (4) games create a relaxed atmosphere that minimizes tension and monotony, resulting in more meaningful learning experiences.

However, despite these benefits, some obstacles emerged during the implementation of the ANIMOPOLI media. For instance, not all students had smartphones with sufficient specifications to run the augmented reality application smoothly, leading to occasional technical issues such as application lag or difficulty scanning the AR markers. Additionally, the use of AR features required extra time for students to learn how to operate the app effectively, which slightly extended the duration of learning activities compared to conventional methods. Teachers also needed to provide more guidance and technical support during the initial use of the AR application to ensure that all students could access and interact with the AR content properly. These challenges suggest that while AR-based game media have high potential to increase motivation and conceptual understanding, successful implementation requires careful planning, device readiness, and teacher preparedness to handle technical support. Future improvements may include providing school-owned devices for students who lack compatible smartphones and streamlining the AR application to ensure it runs smoothly on lower-specification devices (Angganing et al., 2022).

The Augmented Reality (AR) media integrated into the ANIMOPOLI monopoly game was developed through several stages. First, sketches or markers of 3D animal images were created based on the classification of vertebrate animals covered in the curriculum. Next, 3D animal objects were designed and animated using Unity software to produce realistic movements and visualizations. Audio explanations and descriptive texts were added to each 3D object to provide additional information about the characteristics and organ systems of each animal class. The AR features were then integrated into the monopoly board, with each game square containing a unique barcode or marker. When scanned using a smartphone camera via the AR application, the marker triggers the display of the corresponding 3D animal along with audio narration.

The AR application interface was designed with a start page, AR button, information menu, and exit button for easy navigation. Beta testing of the AR application was conducted with a small group of users to evaluate functionality and usability. Feedback obtained during testing was used to make final adjustments to ensure that the AR experience was interactive, user-friendly, and supportive of the learning objectives.After creating a 3D object, a 3D animation is created using Unity software so that an animation that looks real is obtained. Through Unity, 3D animations are also created which will later be used for AR displays. At this stage also added audio and explanations regarding class classification and characteristics of each animal. The AR component visualizes complex concepts such as animal organ systems in a more concrete and interactive manner, which aligns with (Daryanes et al., 2023), who highlighted that digital interactive media can facilitate students' problem-solving and critical thinking skills by presenting abstract scientific material in an accessible format.

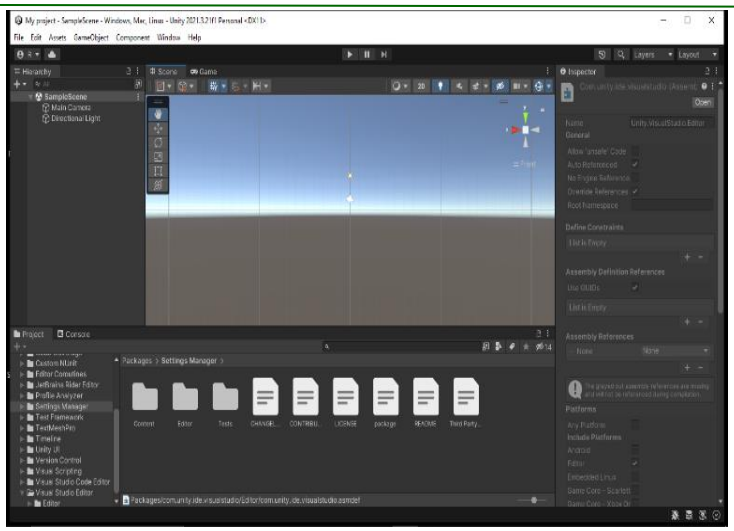

Figure 4. 3D Animation Making Process

When the AR application is opened, you will see the initial display and the AR button menu, the information menu, and the exit button menu. The Ar button menu will scan the marker by directing the smartphone camera at the monopoly board which has animal images so that it will display animal visuals in 3D along with explanations and audio. Users can see animal visuals from various angles such as right, left, above and behind and can see in detail because it can be used with zoom in, zoom out and rotation. After the application has been made, then testing is carried out. This test was carried out using a beta testing approach. In beta testing, it was carried out using a questionnaire to provide an assessment of the AR application that was made. However, unlike some previous studies that focused solely on cognitive outcomes (Edison & Aman, 2024), this study demonstrates that combining AR with a game-based approach can simultaneously enhance not only cognitive but also social and communication skills, which are essential 21st-century competencies. Nevertheless, while the results are encouraging, this study has limitations. The sample size was relatively small, and the study was limited to a single school context. Future studies could replicate this intervention in different settings and with larger samples to validate its generalizability. Additionally, further research could examine long-term retention of knowledge and whether the observed improvements in communication and collaboration persist beyond the immediate learning context.

Figure 5. 3D View of the Start Page Application

Figure 6. 3D Display of AR Animal Classification Application

4. CONCLUSION

MONOPOLY Learning Media based on Augmented Reality has the advantage of being a medium that students can use to better understand animal classification material from a real visual and audio perspective. Based on the results of the study, it was found that students' cognitive scores increased after using MONOPOLY media in the experimental group which showed an N-gain score test score with an average of around 80.14 with an effective category. Communication skills with the average of the experimental group around 87.5, while that of the control group around 48.9. The value of collaboration increased with the average value of the experimental group being around 75, while that of the control group was around 45.83 so that MONOPOLI learning media based on Augmented Reality had an effect on increasing cognitive learning outcomes, communication skills, and collaboration skills of students of SD Rejoyoso 04 Bantur Malang.

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