Pengaruh Research Based Learning dengan Media Augmented Reality (AR) terhadap Kemampuan Berpikir Tingkat Tinggi Siswa

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Abstract
The research index in Indonesia is still considered very low in terms of quality. It is necessary to make research-based thinking relevant in the field of Education as an important sector for the cultivation and development of research. Therefore, the purpose of this study is to determine the effect of Research-Based Education or Research Based Learning (RBL) on high-level thinking skills as an effort to make research values relevant to learning activities. Research-based learning in this study is supported by AR gamification learning media to attract student enthusiasm. This research method uses a pretest-posttest control group design. The results show that research-based learning with AR gamification media has an effect on high-level thinking skills of elementary school students with a significance of 0.042. The value of the experimental class with research-based learning is higher than the control class with direct instruction learning. These results are expected to support the implementation of research-based learning.

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Abstrak
Indeks penelitian di Indonesia masih dinilai sangat rendah dari segi kualitas. Untuk itu perlu direlevasikan pemikiran berbasis penelitian dalam bidang Pendidikan sebagai sektor penting bagi pembinaan dan pengembangan penelitian. Oleh karena itu, tujuan penelitian dalam penelitian ini adalah untuk mengetahui pengaruh Pendidikan Berbasis Penelitian atau Research Based Learning (RBL) terhadap keterampilan berpikir tingkat tinggi sebagai upaya agar nilai-nilai penelitian relevan dalam kegiatan pembelajaran. Pembelajaran berbasis penelitian dalam penelitian ini didukung dengan media pembelajaran gamifikasi AR untuk menarik antusiasme siswa. Metode penelitian ini menggunakan pretest-posttest control group design. Hasil penelitian menunjukkan bahwa pembelajaran berbasis penelitian dengan media gamifikasi AR berpengaruh terhadap keterampilan berpikir tingkat tinggi siswa Sekolah Dasar dengan signifikansi sebesar 0,042. Nilai kelas eksperimen dengan pembelajaran berbasis penelitian lebih tinggi dibandingkan dengan kelas kontrol dengan pembelajaran direct instruction. Hasil tersebut diharapkan dapat mendukung terlaksananya pembelajaran berbasis penelitian.

I. INTRODUCTION

The era of disruption demands a profound renewal across all sectors to achieve innovative, adaptive, and effective conditions. This constant drive for transformation is essential to staying competitive on a global scale, as nations strive to create superior knowledge and cutting-edge technologies (Astikawati et al., 2020). However, in reality, Indonesia still faces significant challenges in this area and is often categorized as a country with a low level of research development (Juditha et al., 2025). According to the Global Innovation Index (GII), Indonesia's research and innovation performance remains dismal, ranking 85th out of 86 countries with a score of only 29.8. This ranking highlights the gap between Indonesia and other countries in terms of fostering innovation and research excellence. Moreover, the GII reports indicate that Indonesia has not shown any significant improvement in its innovation index over a period of five years, from 2014 to 2019, reflecting a concerning stagnation in the country's research and development landscape (Juditha et al., 2021). These findings emphasize the urgent need for systemic changes to accelerate research progress. Additionally, Dimyati highlights that the quality of scientific publications in Indonesia remains far below international standards, as evidenced by the citation index, which is notably disproportionate to the sheer volume of publications (Ratnasari & Nurislaminingsih, 2009). This discrepancy suggests that while the quantity of research outputs may be increasing, the impact and relevance of these works continue to lag behind

those from other countries, further underscoring the critical need for improvement in both the quality and scope of scientific inquiry in Indonesia.Although the number of scientific publications in Indonesia continues to increase, the quality of research produced still lags far behind that of neighboring countries in Southeast Asia. According to data from the Strategic Plan of the Directorate General of Higher Education, Research, and Technology (Ditjen Diktiristek) for 2020–2024, Indonesia ranks 58th globally with an H-index of 259. This figure shows a significant gap compared to Singapore, which has an H-index of 646, reflecting a substantial difference in the quality and impact of research output (Ditjen Diktiristek, 2020). According to Iman, there are several factors contributing to this lag. One of the main issues is the relatively low number and quality of innovators in Indonesia. In addition, the national research ecosystem is considered insufficient to support research activities effectively, whether in terms of regulations, funding, or infrastructure. Furthermore, Indonesia's education system is not yet designed to instill a scientific and research-oriented mindset from an early age. As a result, university students often require additional time just to grasp the basic concepts of scientific thinking and research methodology. This situation ultimately hinders the overall pace of research development in the country (Iman, as cited in Ditjen Diktiristek, 2020).

The impact of the lack of research and innovation quality in Indonesia is multifaceted and deeply entrenched in various sectors of society. This deficiency contributes to an education system that remains rigid and unresponsive to the evolving demands of the global knowledge economy. Consequently, there is a persistent dependency on imported products and technologies, which hinders the development of local industries and innovation. Moreover, the low quality of human resources exacerbates the situation, as individuals are not equipped with the necessary skills and knowledge to drive progress. This, in turn, leads to a decline in critical indicators such as health and well-being, as the lack of innovation affects public health systems and services. Addressing these challenges requires a comprehensive approach that includes fostering a culture of research and innovation across all levels of society.

According to Dwi et al. (2017), one of the pivotal steps to ignite research interest in Indonesia is by encouraging the enhancement of both the quality and quantity of scientific works within the educational environment. This approach aims to cultivate a generation of learners and educators who are not only consumers of knowledge but also active contributors to the scientific community. Such an initiative aligns with the objectives outlined in the Regulation of the Minister for Administrative Reform and Bureaucratic Reform Number 16 of 2009, dated November 10, 2009, concerning the Functional Position of Teachers and Their Credit Scores. This regulation emphasizes that one of the professional development activities for teachers is the production of scientific publications, thereby incentivizing educators to engage in research and scholarly activities. Furthermore, for students, the curriculum incorporates elements that promote adaptive, critical, and innovative learning through research-based learning programs. These programs are designed to equip students with the skills necessary to navigate and contribute to an increasingly complex and dynamic world. By embedding research and innovation into the educational framework, Indonesia can begin to address the systemic issues that hinder its progress and work towards building a more resilient and self-reliant society.

The integration of research in learning is still considered complicated by the majority of students and teachers. Research-Based Learning (RBL) is one of the student-centered learning (SCL) methods that often fails to be implemented, especially at the elementary school level (Lakiama, 2022). This failure is due to the lack of scenarios and learning media products that can guide students in carrying out RBL. According to Yatra, gamification is one of the strategies to enhance students' understanding, especially at the elementary school level, of a learning path that is difficult but very important for student development (Hanifah & Adopsi, 2017). Therefore, the aim of this research is to measure the effectiveness of research-based learning using Augmented Reality (AR) technology in enhancing higher-order thinking skills in elementary school students.

II. METHOD

The learning media used adapts the Jenga game, integrated with an AR system. The flow used in this media is based on a scientific thinking process, which includes problem, observation, hypothesis, experiment, and conclusion. The media consists of a handbook, website, modified Jenga game integrated with

AR, and Assmblr Studio (AR imaging). The handbook contains simulations of problems and solutions that can be offered to help students understand the concept of RBL. The Jenga game presents problems with solutions in the form of clues, allowing students to practice higher-order thinking. The website provides guidelines and summaries of news in society for analysis. Below is the flow of using the AR-based gamification learning media.

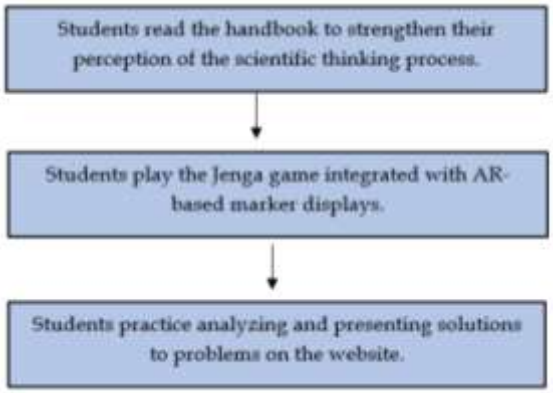

Figure 1. Flow of AR Gamification Learning Media

This research is a type of quasi-experimental study. The research design used includes a pretest-posttest control group design with a descriptive qualitative method. The population in this study consists of all 23 students from Class V of SDN 1 Sumbersari. The sampling technique used is random sampling. The experimental class, with the RBL learning model treatment, consists of 12 students, while the control class, using the direct instruction model, consists of 11 students.

The independent variable in this study is the Research-Based Learning (RBL) model. The dependent variables are student learning independence and higher-order thinking skills. Higher-order thinking skills in this study include the aspects of analyzing, evaluating, and creating. Learning independence refers to self-management, desire for learning, and self-control. RBL in this study is a learning model consisting of five phases: Phase 1 - Orientation to the problem, Phase 2 - Analysis and reference management, Phase 3 - Investigation, Phase 4 - Solution and creation development, Phase 5 - Solution demonstration and evaluation.

The higher-order thinking instrument was adapted from the development instrument by Fitriana (2019), while the learning independence instrument was adapted from the development of the learning independence instrument in the study by Audhida et al. (2022). The data analysis technique in this study uses parametric inferential statistics. The instruments were validated by experts and tested for validity, reliability, item difficulty, and discriminative power. The data analysis in this study used parametric inferential statistics, with data analysis conducted using SPSS 16.0 for Windows.

III. RESULT AND DISCUSSION

In this study, data were obtained from the results of the pretest and posttest conducted in both the experimental and control classes. The purpose of the pretest was to determine whether the initial abilities of students in both classes were the same. The initial abilities of the students in the experimental and control classes can be seen in Table 1.

Table 1. Initial Student Abilities Data

Class	Number of Students	Max Score	Min Score	Average Score	Standard Deviation
X	12	67	42	51.8	8.2
Y	11	67	42	53.2	7.8

Note:
X = Experimental
Y = Control

Table 1 shows that the average initial ability score of students in the experimental class is 51.8, while the control class has an average score of 53.2. This indicates that the average initial ability in both classes is still low and below the Minimum Completion Criteria (KKM) for the Science subject.

The following are the data for higher-order thinking skills, obtained from the post-test scores conducted in both the experimental and control classes after students received the material on the diversity of living organisms. The test consisted of 5 questions designed to measure higher-order thinking skills.

Table 2. Higher-Order Thinking Skills Data

Class	Number of Students	Max Score	Min Score	Average Score	Standard Deviation
X	12	100	60	80.8	11.9
Y	11	100	49	71.9	13.9

Note:
X = Experimental
Y = Control

In Table 2, it can be explained that there is a significant descriptive difference in the higher-order thinking skills and learning independence between the experimental group applying the

Research-Based Learning (RBL) model and the control group applying direct instruction. The students who were given the RBL learning model treatment had an average score of 80.8, while the control class using the direct instruction method had an average score of 71.9.

The hypothesis test conducted shows that, descriptively, the higher-order thinking skills of the 4th-grade students who received the RBL learning model treatment were better than those in the direct instruction learning group. This can be seen from the average higher-order thinking skill score of RBL participants being higher than that of the direct instruction participants. The results and discussion of the hypothesis test are as follows.

The hypothesis test conducted reveals that the significance value is 0.042, which is less than the 0.05 threshold, leading to the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_1). This indicates a statistically significant difference between the experimental class, which received the Research-Based Learning (RBL) model, and the control class, which underwent direct instruction. Research-Based Learning is a form of contextual learning that emphasizes real-world issues and encourages students to engage in problem-solving and critical thinking. In this approach, students analyze contextual information, formulate hypotheses, utilize existing knowledge, and seek new information to develop potential solutions. The effectiveness of RBL is often enhanced by providing opportunities for active discussion and debate, allowing learners to assimilate existing knowledge or new contexts and articulate their learning. Studies have shown that contextual learning models like RBL significantly improve students' higher-order thinking skills. For instance, a study by Calista et al. (2022) found that contextual teaching and learning positively affected students' higher-order thinking skills in geometry. Similarly, research by Hobri et al. (2019) demonstrated that contextual teaching and learning, when combined with lesson study for learning communities, enhanced students' higher-order thinking skills in mathematics. These findings align with the results of the current study, supporting the efficacy of the RBL model in fostering critical thinking and problem-solving abilities among students.In this study, data were obtained from the results of the pretest and posttest conducted in both the experimental and control classes. The purpose of the pretest was to determine whether the initial abilities of students in both classes were the same. The initial abilities of the students in the experimental and control classes can be seen in Table 3.

Table 3. Initial Student Abilities Data

Class	Number of Students	Max Score	Min Score	Average Score	Standard Deviation
X	12	67	42	51.8	8.2
Y	11	67	42	53.2	7.8

Note:
X = Experimental
Y = Control

Table 1 shows that the average initial ability score of students in the experimental class is 51.8, while the control class has an average score of 53.2. This indicates that the average initial ability in both classes is still low and below the Minimum Completion Criteria (KKM) for the Science subject.

The following are the data for higher-order thinking skills, obtained from the post-test scores conducted in both the experimental and control classes after students received the material on the diversity of living organisms. The test consisted of 5 questions designed to measure higher-order thinking skills.

Table 4. Higher-Order Thinking Skills Data

Class	Number of Students	Max Score	Min Score	Average Score	Standard Deviation
X	12	100	60	80.8	11.9
Y	11	100	49	71.9	13.9

Note:
X = Experimental
Y = Control

In Table 2, it can be explained that there is a significant descriptive difference in the higher-order thinking skills and learning independence between the experimental group applying the Research-Based Learning (RBL) model and the control group applying direct instruction. The students who were given the RBL learning model treatment had an average score of 80.8, while the control class using the direct instruction method had an average score of 71.9.

The hypothesis testing conducted indicates that, descriptively, the higher-order thinking skills of 4th-grade students who received the Research-Based Learning (RBL) treatment were superior to those in the direct instruction group. This conclusion is drawn from the comparative average scores of higher-order thinking skills

between the two groups, where the RBL participants consistently achieved higher average scores than the direct instruction participants. The difference in performance suggests that the RBL model may provide a more effective framework for fostering complex cognitive skills such as analysis, evaluation, and synthesis, which are crucial components of higher-order thinking. The structured inquiry and active engagement elements embedded in the RBL approach likely contributed to the development of these advanced thinking skills. Furthermore, research supports the effectiveness of RBL in enhancing critical thinking skills. A study by Reyk et al. (2022) found that the RBL model significantly improved students' critical thinking skills in science education. Similarly, Mahardini et al. (2021) highlighted that RBL's emphasis on authentic learning, problem-solving, and inquiry-based approaches effectively nurtures critical thinking abilities. These findings align with the observed outcomes in this study, reinforcing the potential of RBL to enhance higher-order thinking skills in elementary education.The results of the hypothesis test show that the significance value is 0.042 < 0.05, so H0 is rejected and H1 is accepted. This indicates that there is a significant difference between the experimental class and the control class. Research-Based Learning (RBL) is a form of contextual learning. Its context triggers cues to stimulate the development of issues related to the topic field. In the process, learners analyze contextual information, formulate hypotheses, use existing knowledge, or seek new information to come up with possible solutions. The effects of RBL are often optimized by providing opportunities for active discussion and debate, where learners can assimilate existing knowledge or new contexts and articulate their learning.

IV. CONCLUSION AND SUGGESTION

A. Conclusion

Based on the results of the hypothesis testing and the detailed discussion of the research, several conclusions can be drawn regarding the impact of different learning methods on student outcomes. First, the research found a significant difference in both higher-order thinking skills and learning independence between students who participated in research-based learning and those who underwent direct instruction. This suggests that the research-based learning model fosters more advanced cognitive skills, such as analysis, evaluation, and synthesis, which are crucial for students' academic growth. In addition, students engaged in research-based learning showed greater autonomy in managing their learning process, demonstrating improved self-regulation and motivation.

Another key finding from the study is the significant role of augmented reality (AR)-based gamification learning media in enhancing students' interest and enthusiasm for research-based learning. By integrating interactive and immersive technologies, AR-based gamification transforms traditional learning environments into dynamic and engaging spaces. This approach not only captures students' attention but also encourages them to actively participate in the learning process, thereby improving their overall learning experience. The use of such innovative learning tools significantly supports students' enthusiasm and promotes sustained engagement, which is essential for effective learning in the research-based context.

Overall, the findings of this research underscore the potential benefits of adopting research-based learning strategies and incorporating advanced learning technologies, such as AR gamification, in educational settings. These approaches help develop critical thinking, foster independence, and increase student motivation, all of which are essential for preparing students to thrive in an increasingly complex.

B. Suggestion

Based on the findings, it is suggested that educators integrate research-based learning approaches supported by innovative technologies like AR gamification to enhance students' higher-order thinking, independence, and motivation, thereby creating a more engaging and effective learning environment.

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