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Demikian tugas ini diberikan untuk dilaksanakan dengan sebaik-baiknya sebagai amanah dan ibadah kepada Allah Subhanahu wa Ta'ala. Setelah melaksanakan tugas agar memberikan laporan kepada pemberi tugas.

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The Effectiveness of Inquiry Based Learning Assisted by Gizmos

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ABSTRAK

Penelitian ini bertujuan untuk menganalisis keefektifan penerapan model Pembelajaran Berbasis Inkuiri yang didukung simulasi Gizmos terhadap hasil belajar IPAS siswa sekolah dasar. Penelitian ini memakai pendekatan kuantitatif dengan metode *quasi-eksperimental* dan desain *nonequivalent control group design*. Sampel penelitian terdiri dari dua kelas, yaitu kelas eksperimen dan kelas kontrol, dengan total 64 siswa. Instrumen yang dipakai adalah tes hasil belajar yang diberikan melalui pretest dan posttest. Analisis data dilakukan menggunakan analisis deskriptif, uji normalitas, uji homogenitas, uji Wilcoxon, uji Mann-Whitney, dan analisis N-Gain. Hasil penelitian menunjukkan bahwa ada perbedaan signifikan antara hasil belajar siswa di kelas eksperimen dan kelas kontrol, dengan nilai signifikansi 0,000 <0,05. Selain itu, peningkatan hasil belajar di kelas eksperimen berada pada kategori sedang (0,57), sedangkan di kelas kontrol berada pada kategori rendah (0,29). Dengan demikian, dapat disimpulkan bahwa penerapan Pembelajaran Berbasis Inkuiri yang didukung oleh Gizmos efektif dalam meningkatkan hasil belajar sains siswa sekolah dasar.

Keywords : *Pembelajaran Berbasis Inkuiri, Gizmos, hasil pembelajaran, sains, sekolah dasar*

ABSTRACT

This study investigates the effectiveness of inquiry-based learning with Gizmos simulations on the science learning outcomes of elementary school students. The study employs a quantitative approach with a quasi-experimental method using a nonequivalent control group design. The sample comprised two classes—an experimental class and a control class—with a total of 64 students. A learning outcome test, administered before and after the intervention, served as the research instrument. Data analysis was performed using descriptive analysis as well as tests for normality, homogeneity, Wilcoxon, Mann-Whitney, and N-gain values. The results show a significant difference between the learning outcomes of students in the experimental class and the control class ($p < 0.001$). The increase in learning outcomes in the experimental class was rated as moderate (0.57) and in the control class as small (0.29). Therefore, it can be concluded that the application of inquiry-based learning supported by Gizmos effectively improves the science learning outcomes of elementary school students.

Keywords : *Inquiry Based Learning, Gizmos, learning outcomes, science, elementary school*

INTRODUCTION

Natural and Social Sciences (IPAS) learning in elementary schools plays a crucial role in developing students' conceptual understanding and scientific thinking skills from an early age. In the implementation of the Independent Curriculum, IPAS learning is directed towards a student-centered and experience-based approach, encouraging students to actively observe, question, investigate, and draw conclusions. This approach aligns with constructivism theory, which emphasizes that knowledge is not transferred directly from teacher to student but is constructed through interaction with the environment and meaningful learning experiences (Mekonen & Kelkay, 2023). Therefore, IPAS learning ideally fosters critical thinking skills, curiosity, and problem-solving abilities. However, classroom practices do not always reflect these expectations, as learning activities are often still dominated by teacher-centered instruction and limited opportunities for students to engage in active inquiry.

However, learning conditions in elementary schools still show various limitations. Based on preliminary observations conducted in a fourth-grade classroom at an elementary school in East Jakarta, science instruction was still largely dominated by teacher explanations and textbook use, with

limited student participation during lessons. Interactive learning media were rarely used, and the school did not yet have adequate laboratory facilities to support simple experiments. As a result, students had difficulty understanding abstract topics that require process visualization, particularly the plant life cycle, since they could not directly observe stages such as germination, growth, pollination, and seed formation. This situation also contributed to low classroom engagement, as many students tended to be passive and relied mainly on teacher explanations. Similar findings were reported by Munawarah et al., (2024) who found that conventional instruction tends to produce lower learning outcomes than learning activities that involve exploration and active participation.

To address this issue, a learning model is needed that can encourage active student participation in the learning process. One model considered relevant is Inquiry-Based Learning (IBL), which places students at the center of learning through activities such as identifying problems, proposing hypotheses, conducting investigations, and drawing conclusions (Aregehagn et al., 2022). This model provides students with the opportunity to construct their own understanding through exploration. Previous studies have shown that implementing Inquiry-Based Learning can significantly improve student learning outcomes and critical thinking skills (Cairns, 2019). Furthermore, the inquiry approach has been shown to be effective in helping students gain a deeper understanding of science concepts because it directly engages them in the learning process (Sturrock et al., 2025).

However, the success of implementing Inquiry-Based Learning depends heavily on the availability of media that support investigations. Without experimental facilities, the inquiry process is less than optimal because students lack the means to directly test hypotheses. Therefore, alternative learning media are needed that can effectively simulate the experimental process. One solution is the use of virtual laboratories. Research (Coleman & Hosein, 2022) shows that the use of virtual simulations in science learning can improve students' conceptual understanding because it allows for flexible and interactive exploration. Furthermore, digital simulations also provide opportunities for students to conduct repeated experiments without the constraints of equipment and time (Alstein et al., 2025).

In this study, Gizmos was selected as the learning media because previous studies have shown its potential to support science learning through interactive simulation features. As a web-based virtual laboratory platform, Gizmos enables students to manipulate variables, observe changes, and draw conclusions based on visualized phenomena. This feature is particularly relevant for elementary science topics that involve abstract processes and sequential changes, such as the plant life cycle. Previous research by Jariah et al., (2025) reported that Gizmos-assisted virtual laboratories can improve students' critical thinking skills. In addition, Cruz et al., (2024) found that the use of Gizmos simulations increased students' motivation and engagement during science learning. These findings indicate that Gizmos is not only practical to use in classroom settings, but also pedagogically relevant for supporting inquiry-based learning.

The integration of Inquiry-Based Learning and Gizmos offers the opportunity to create more meaningful and interactive learning. In this process, students not only engage in conceptual scientific thinking but also gain hands-on experimental experience through digital simulations. This combination helps students grasp abstract concepts more easily, supported by dynamic and interactive visualizations. Research conducted by Ismailov, (2021) shows that inquiry-based learning supported by digital technology can improve students' conceptual understanding and scientific communication skills.

Although numerous studies on Inquiry-Based Learning and virtual laboratories have been conducted, most previous research has focused on secondary or higher education settings. Studies involving elementary school students are still relatively limited, particularly those examining the combination of Inquiry-Based Learning with Gizmos-based digital simulations. In addition, few studies have specifically investigated its effect on students' learning outcomes in science topics that require process visualization, such as the plant life cycle, using a quasi-experimental comparison between experimental and control groups. Evidence from Indonesian elementary school contexts is also still scarce. Therefore, this study seeks to address these gaps by examining the effectiveness of Gizmos-assisted Inquiry-Based Learning on fourth-grade students' science learning outcomes.

Based on this description, this study investigates the effectiveness of inquiry-based learning using digital tools on students' science learning outcomes. The results of this study are intended to provide an empirical contribution to the development of technology-supported learning and as an alternative solution to limited learning opportunities in elementary schools.

RESEARCH METHODS

This study used a quantitative approach with a quasi-experimental method. The research design used was an Nonequivalent Control Group Design, involving two groups, an experimental class and a control class, which were not selected randomly but based on the existing classes. Both groups were given a pretest before the treatment and a posttest after the treatment to determine differences in student learning outcomes.

This research was conducted in the even semester of the 2024/2025 academic year at an elementary school in East Jakarta. The population consisted of all fourth-grade students, consisting of three classes with a total of 96 students. The sampling technique used was cluster sampling, thus two classes were selected as research samples with a total of 64 students. Class IV A (32 students) was designated as the experimental class, while class IV B (32 students) was designated as the control class.

The experimental class was given treatment using the Inquiry-Based Learning model assisted by Gizmos simulations, while the control class used conventional learning. The Inquiry-Based Learning model was implemented through the stages of orientation, problem formulation, hypothesis development, data collection through Gizmos simulation exploration, hypothesis testing, and conclusion drawing. The use of Gizmos enabled students to conduct virtual experiments by manipulating variables and observing phenomena interactively.

The research instrument consisted of a multiple-choice test on learning outcomes, administered during the pretest and posttest. This instrument was developed based on indicators from the revised Bloom's Taxonomy of Cognitive Domains, including understanding, application, analysis, and evaluation. Prior to use, the instrument was tested for validity and reliability to ensure its suitability as a measurement tool.

Data collection techniques included administering pre- and post-treatment tests. Pre-test data was used to identify students' initial abilities, while post-test data was used to measure learning outcomes after the learning process.

Data analysis was performed using statistical software. The initial stage involved descriptive analysis to determine the mean, minimum, maximum, and standard deviation. Next, normality and homogeneity tests were performed as prerequisites. The normality test results indicated that the data were not normally distributed, while the homogeneity test indicated that the data had homogeneous variance.

Based on these results, hypothesis testing was conducted using nonparametric tests. The Wilcoxon Signed Rank test was used to determine differences in learning outcomes before and after treatment in each group, while the Mann–Whitney U test was used to examine differences in learning outcomes between the experimental and control classes. Furthermore, improvements in student learning outcomes were analyzed using N-Gain to determine the level of improvement after the learning process.

RESULTS & DISCUSSION

Results

Research data were obtained from pretest and posttest scores from the experimental and control classes. Descriptive analysis was used to determine student learning outcomes before and after treatment.

Table 1. Descriptive Statistics of Pretest and Posttest

Data	N	Min	Max	Mean	SD
Pre-Ex	32	40	70	58.75	9.755
Post-Ex	32	70	100	82.50	9.158
Pre-Con	32	40	70	58.75	9.755
Post-Con	32	60	80	70.94	7.771

Table 1 shows that the average pretest score in the experimental and control classes was the same, at 58.75. This indicates that students' initial abilities in both groups were similar before the treatment. After the learning process, the average posttest score in the experimental class increased to 82.50, while in the control class it reached 70.94. This finding indicates that learning outcomes in the experimental class were higher than in the control class.

The results of the normality test showed that all data had a significance value below 0.05, indicating that the data were not normally distributed. Meanwhile, the homogeneity test yielded a significance value of 0.533 (>0.05), indicating that the data variance was homogeneous across the two groups. Therefore, the hypothesis testing was conducted using the nonparametric Mann–Whitney test.

Table 2. Mann-Whitney Test Results

Statistics	Mark
Mann–Whitney U	194.000
Z	-4.471
Sig. (2-tailed)	0.000

From Table 2, the significance value obtained was 0.000 < 0.05, indicating a statistically significant difference in learning outcomes between the experimental class and the control class. Therefore, the research hypothesis stating that the Inquiry-Based Learning model assisted by Gizmos affects the science learning outcomes of fourth-grade elementary school students is accepted. In practical terms, this result suggests that students who learned through Gizmos-assisted Inquiry-Based Learning were better able to understand the lesson content than those who experienced conventional instruction. The combination of active inquiry processes and interactive simulations appears to provide more meaningful learning experiences, particularly for topics that involve abstract processes such as the plant life cycle.

To determine the level of improvement in student learning outcomes after the learning process, an analysis was conducted using the N-Gain Score, as shown in Table 3.

Table 3. N-Gain Score

Class	Mean N-Gain	Category
Experimental	0.57	Medium
Control	0.29	Low

Table 3 shows that the improvement in learning outcomes in the experimental class was in the moderate category, while the improvement in the control class was in the low category. This indicates that the use of Inquiry-Based Learning with Gizmos was more effective in improving student learning outcomes than conventional learning. The difference in improvement likely occurred because students in the experimental class were actively involved in observing, discussing, and drawing conclusions during the learning process. In addition, the Gizmos simulation helped students visualize the stages of the plant life cycle more clearly, making abstract concepts easier to understand. In contrast, students in the control class mainly relied on teacher explanations, which provided fewer opportunities for active exploration and conceptual construction.

Discussion

The research results show that the implementation of Inquiry-Based Learning supported by Gizmos can significantly improve student learning outcomes compared to conventional learning. One possible reason is that Inquiry-Based Learning encourages students to construct their own understanding through direct investigation rather than passively receiving information from the teacher. When students are involved in observing phenomena, asking questions, testing ideas, and drawing conclusions, they process information more actively and meaningfully. This learning process helps students connect new concepts with prior knowledge, which may strengthen conceptual understanding and retention. In addition, inquiry activities require students to think critically and solve problems during the lesson, allowing them to engage cognitively with the material. These characteristics make learning more meaningful than conventional instruction, where students often rely mainly on explanation and memorization. This finding is consistent with research by Aregehagn et al., (2022), which showed that active participation in inquiry learning contributes to improved student conceptual understanding. Similar results were also reported by Mekonen & Kelkay (2023) who stated that inquiry strategies can improve students' learning outcomes and scientific skills.

Furthermore, the application of the inquiry-based learning model in this study also provides students with opportunities to develop higher-order thinking skills. The process of identifying problems, formulating hypotheses, and analyzing data encourages students to think critically and

systematically. These activities enable students not only to understand the material but also to connect concepts to the phenomena they observe. This aligns with the findings of Arifin, (2025) who stated that inquiry-based learning is effective in improving students' critical thinking skills. Furthermore, research by Gholam (2019) shows that inquiry-based learning can increase students' active engagement in the learning process, both cognitively and participatively.

The role of learning media in this study also contributed to the improvement in learning outcomes. The use of Gizmos as a virtual simulation provided a more concrete learning experience through interactive visualization. The concept of the plant life cycle, which was previously difficult to observe directly, became easier to understand because students could see the process dynamically. Siew & Chai (2024) stated that the use of simulations in learning can improve conceptual understanding through interactive visual representations. This finding is supported by Antonio & Prudente (2024), who demonstrated that integrating inquiry-based learning with technology support can help students understand abstract concepts more effectively.

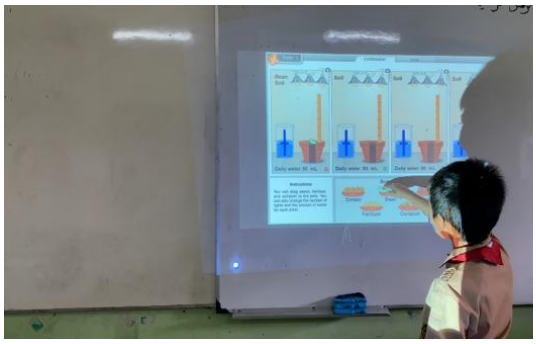

Figure 1. Learning Activities using Gizmos Simulation

Figure 1 shows how students are directly involved in observing the simulation. This activity demonstrates that learning is no longer one-way, but rather involves interaction between students and the learning media. Through this visual experience, students more easily grasp concepts because they can directly see the process being learned. Furthermore, the use of virtual laboratories provides flexibility in the learning process. Students can explore without being limited by the availability of tools and time, and can even repeat experiments until they fully understand the concept. Muhamad et al., (2024) explained that the use of simulations in science learning can increase learning effectiveness. This finding is supported by Siew & Chai (2024) and Antonio & Prudente (2024), who showed that simulation-based learning not only provides a more in-depth learning experience but also improves students' conceptual understanding and higher-order thinking skills. Taken together, these findings indicate that digital simulations can make science learning more interactive, flexible, and meaningful for elementary school students.

On the other hand, learning success is also influenced by the collaborative activities students engage in during the inquiry process. Students work in groups to discuss observations and draw conclusions together. This process not only enhances conceptual understanding but also fosters communication and collaboration skills. Through group discussions, students have opportunities to exchange ideas, compare different viewpoints, and clarify misunderstandings that may arise during learning. Explaining ideas to peers can also strengthen students' own understanding, while listening to others helps them consider alternative ways of thinking. In addition, collaborative inquiry encourages students to participate more confidently and take shared responsibility for solving learning tasks.

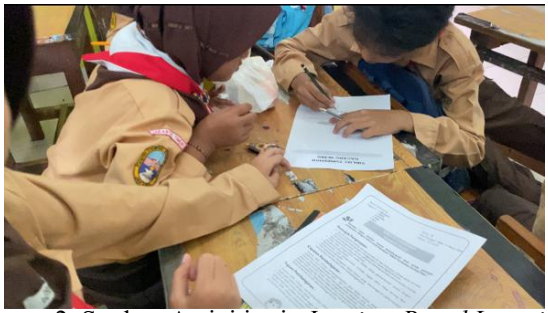

Figure 2. Student Activities in *Inquiry -Based Learning*

Figure 2 shows that students are actively involved in group discussions. This activity is one of the main characteristics of inquiry-based learning, where students learn through interaction and the exchange of ideas. From the perspective of engagement theory, active participation in discussion reflects students' behavioral and cognitive involvement in meaningful learning tasks, which can increase motivation and persistence during classroom activities (Kearsley & Shneiderman, 1998). In addition, this interaction is closely related to the principles of social constructivism, which view knowledge as being developed through communication, collaboration, and shared meaning-making with others (Vygotsky, 1978). Through group discussions, students can explain ideas, respond to different viewpoints, and refine their understanding together. Recent research also shows that inquiry-based learning combined with collaborative activities can significantly increase student motivation and engagement (Sujarwo et al., 2025).

Lower learning outcomes compared to control classes indicate that conventional teaching methods often fail to provide a deep learning experience. When the teacher remains the sole focus, students tend to be more passive and less engaged in the process, ultimately hindering their conceptual understanding.

These results are consistent with Qamariyah et al., (2021), who noted that traditional learning is less effective in building a solid conceptual foundation. Furthermore, a meta-analysis by Mediana Jr et al., (2025) highlighted that inquiry-based learning was significantly more successful than traditional methods in improving student understanding. These points are further reinforced by Tian et al., (2025), who found that inquiry-based approaches significantly improved learning outcomes and student engagement more effectively than conventional classroom settings.

Overall, the findings of this study indicate that the implementation of Inquiry-Based Learning (IBL) assisted by Gizmos not only improves student learning outcomes but also increases engagement, motivation, and deeper conceptual understanding. The integration of active learning models with digital technology provides a more meaningful learning experience for students. Therefore, the use of inquiry-based models supported by digital simulations can be an effective alternative strategy to improve the quality of science learning in elementary schools.

CONCLUSION & SUGGESTION

Based on the research findings and discussions, it can be concluded that the use of the Inquiry-Based Learning model combined with Gizmos simulations effectively improves science learning outcomes for fourth-grade students. This is clearly seen from the significant difference in results between the experimental and control groups, as well as the higher N-Gain scores in the experimental class. Therefore, this study aims to analyze how effective the Inquiry-Based Learning model supported by Gizmos is in improving student learning outcomes.

These improved learning outcomes occurred because inquiry-based learning encouraged active student engagement in the learning process through exploration, observation, and drawing conclusions. Furthermore, the use of Gizmos simulations as virtual laboratories provided a more concrete, interactive, and flexible learning experience, helping students better grasp abstract concepts.

Based on these results, it is recommended that teachers adopt the Inquiry-Based Learning model, combined with digital simulations, as a new way to improve the quality of science learning. Schools should also encourage the use of educational technology to help bridge the gap when laboratory facilities are limited. Furthermore, future studies can apply this model to different subjects and grade levels to further contribute to the field of education.

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