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The Effect of Using Minecraft: Education Edition on Students' Conceptual Understanding and Collaboration

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Abstract

This study examines the effect of Minecraft: Education Edition on students' conceptual understanding and collaboration in Social and Natural Sciences (IPAS) learning. A quasi-experimental design with a pretest-posttest control group was used, involving 48 sixth-grade students from SDN Srambah. The sample was divided into an experimental group (Class VI A, 24 students) using Minecraft: Education Edition, and a control group (Class VI B, 24 students) receiving conventional instruction, selected through purposive sampling. Instruments included a conceptual understanding test and a collaboration questionnaire. Descriptive statistics showed a greater increase in the experimental group's scores. Data met assumptions for parametric testing based on normality and homogeneity tests. MANOVA results indicated a significant effect of learning media on both outcomes ($p < 0.001$). Further tests of Between-Subjects Effects revealed that the learning method accounted for 91.9% of the variance in conceptual understanding and 94.8% in collaboration. These results suggest that Minecraft: Education Edition is more effective than traditional methods in enhancing both cognitive and collaborative skills. The findings support constructivist learning theory, highlighting the benefits of interactive, student-centered environments in fostering active engagement and meaningful learning.

Keywords: Collaboration Skills, Conceptual Understanding, Game-Based Learning, Minecraft.

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INTRODUCTION

Education in the twenty-first century emphasizes the need for students to develop not only conceptual understanding but also higher-order skills such as critical thinking, problem-solving, and collaboration (Miterianifa et al., 2021; Thornhill-Miller et al., 2023). In the context of Science and Social Studies (IPAS) at the elementary level, conceptual understanding serves as a foundation that enables students to relate scientific concepts to real-life phenomena in their environment (Fradina et al., 2022; Komariah et al., 2023; Susandra et al., 2025). However, preliminary observations at SDN Srambah, located in Proppo District, Pamekasan Regency, reveal that many students still struggle to deeply comprehend IPAS material (Komariah et al., 2023; Ni Kadek Sinta Ulandari et al., 2024; Suprapmanto

& Zakiyah, 2024). Their learning tends to rely heavily on rote memorization rather than meaningful understanding of interconnected concepts. Furthermore, students' collaboration skills remain underdeveloped, as evidenced by their difficulties during group activities and classroom discussions.

Interviews with several students revealed that many find IPAS learning unengaging because it is still dominated by lecture-based methods and written exercises (Antonius, 2023; Priyatno, 2025). Students tend to be passive and less actively involved in the learning process (Tesfaye & Berhanu, 2015), which hampers their ability to explore concepts in depth (Morgado, 2010). When given group tasks, some students also admitted experiencing difficulty in communicating with peers, dividing responsibilities, or expressing their ideas. Most students prefer to work individually rather than collaborate, which limits their development of teamwork skills (Jaiswal et al., 2021; Tanisha et al., 2024).

To overcome these challenges and improve students' conceptual understanding and collaboration skills, game-based learning has emerged as a promising alternative (Adipat et al., 2021; Duncan, 2020; Muttaqien et al., 2021). One educational game that is increasingly used in classrooms is Minecraft: Education Edition. This game enables students to explore IPAS concepts through direct, immersive experiences in a virtual world. With its interactive features, students can build structures, conduct simulations, and complete challenges related to IPAS topics, such as the water cycle, ecosystems, or environmental conservation. This approach aligns with constructivist theory, which emphasizes that students learn more effectively through hands-on experiences and active engagement with their environment.

In terms of collaboration, Minecraft: Education Edition offers features that allow students to work together in a shared virtual environment, communicate effectively, delegate responsibilities, and solve problems as a team. This helps students practice idea sharing, joint decision-making, and appreciate the value of teamwork in achieving shared goals. Previous research has also shown that educational games can increase student motivation and engagement (Jaramillo-Mediavilla et al., 2024).

A study by Kemba et al. (2022) demonstrated that the use of a scientific inquiry-based approach significantly improved student learning outcomes in environmental pollution topics within IPAS. However, this approach has yet to fully integrate the potential of digital technology as an interactive learning medium, which becomes the focus of the present study.

Initial findings at SDN Srambah also indicate that students show a strong interest in technology-enhanced learning. Some students even reported that they better understand the material when it is delivered in a visual and interactive format (Fatimah & Seriwati, 2024; Jannah & Nuriana, 2024). While existing studies have explored the general benefits of digital media and educational games in enhancing student engagement and academic performance, few have specifically examined the use of Minecraft: Education Edition in the context of IPAS learning at the elementary level. Moreover, much of the existing literature emphasizes cognitive outcomes without delving deeply into collaboration skills in real classroom contexts (Lee et al., 2024). Therefore, this study seeks to fill this gap by evaluating the effectiveness of Minecraft: Education Edition in enhancing both conceptual understanding and collaboration among elementary students. The findings are

expected to contribute to the development of more engaging and effective instructional strategies, and to underscore the potential of educational technology in improving the quality of IPAS instruction (Karsenti & Bugmann, 2017; Lestari et al., 2025; Suryani et al., 2025).

RESEARCH METHOD

This research employed a quantitative methodology, utilizing a quasi-experimental framework, precisely a pretest-posttest control group design (Stratton, 2019). Two groups of sixth-grade students at SDN Srambah participated in the study. The experimental group received instruction using Minecraft: Education Edition in IPAS (Science and Social Studies) lessons, while the control group was taught using conventional methods such as lectures and textbook-based discussions. The research flow was carried out in five stages: (1) administering a pretest to both groups to assess their initial conceptual understanding, (2) implementing the treatment where the experimental class engaged in Minecraft-based learning and the control class continued with traditional instruction, (3) observing student collaboration during group activities in both groups, (4) administering a posttest to measure learning gains, and (5) distributing a motivation and perception questionnaire to the experimental group to gather feedback about their experience. This design allowed the researcher to measure and compare the effectiveness of digital game-based instruction with conventional teaching approaches in terms of conceptual understanding and collaboration skills.

The population of the study included all sixth-grade students at SDN Srambah, Proppo District, Pamekasan Regency. The sample was selected using purposive sampling based on the recommendation of the school principal and teacher. Class VI A, consisting of 24 students, was designated as the experimental group, while class VI B, also with 24 students, served as the control group. This selection was based on considerations of class equivalence in terms of academic ability and previous exposure to the subject matter.

The instruments used in this study consisted of a conceptual understanding test, a collaboration observation sheet, and a student motivation and perception questionnaire. The conceptual understanding test included both pretest and posttest items aligned with IPAS competencies to assess students' cognitive development before and after the treatment. The collaboration observation sheet was used to evaluate students' interpersonal behaviors during group work, including communication, participation, and teamwork. Meanwhile, the questionnaire—administered only to the experimental group—measured students' engagement, interest, and perceptions of the Minecraft-based learning experience.

Data were collected systematically through multiple methods. The pretest was given before the intervention to determine students' baseline conceptual understanding. During the learning sessions, observations were made on collaborative behaviors in both classes. After the intervention, the posttest was administered to measure learning improvements. In addition, the experimental group completed a motivation and perception questionnaire to provide further insights into the effectiveness of the learning media from the students' point of view.

Data analysis involved both descriptive and inferential statistical techniques. Initial analysis began with normality and homogeneity tests to ensure that the data

met the assumptions required for parametric testing. Once these conditions were satisfied, an Independent Samples T-Test was conducted to identify significant differences between the experimental and control groups' posttest scores. Descriptive statistics were used to analyze the observation data and student questionnaire responses. Furthermore, an N-Gain test was applied to determine the effectiveness level of the intervention, referring to the guidelines by Triyono et al. (2024), where the gain scores were interpreted to classify the magnitude of students' learning improvements.

RESULTS AND DISCUSSION

Research Results

Descriptive Test

This study analyzed two main variables, namely conceptual understanding and student collaboration, measured through pretests and posttests in two groups: the experimental class, which followed learning using Minecraft: Education Edition, and the control class, which received conventional instruction. The following are the descriptive statistical results of the pretest and posttest scores in both groups.

Table 1. Descriptive Statistics of Experimental Class

Variable	N	Mean	Std. Deviation	Minimum	Maximum
Pretest Concept	24	57.83	1.96	54	61
Posttest Concept	24	82.21	3.28	73	91
Pretest Collaboration	24	60.33	1.80	56	63
Posttest Collaboration	24	87.50	2.55	81	93

Based on the descriptive statistics of the experimental group consisting of 24 students, there was a significant increase after implementing Minecraft: Education Edition in the learning process. The average conceptual understanding score increased from 57.83 to 82.21, while the average collaboration skill score rose from 60.33 to 87.50. This increase indicates that the use of Minecraft: Education Edition had a positive impact on students' conceptual understanding and collaboration.

Table 2. Descriptive Statistics of Control Class

Variable	N	Mean	Std. Deviation	Minimum	Maximum
Pretest Concept	24	58.08	1.99	54	63
Posttest Concept	24	68.17	2.44	62	72
Pretest Collaboration	24	60.58	1.81	57	64
Posttest Collaboration	24	70.71	2.60	65	76

Based on the descriptive statistics of the control group, also consisting of 24 students, there was an increase from pretest to posttest, but not as large as in the experimental group. The average conceptual understanding score increased from 58.08 to 68.17, and the average collaboration score rose from 60.58 to 70.71. Although there was an improvement, the gain was relatively small, indicating that the conventional teaching method used in the control group did not have a

significant impact on students' conceptual understanding and collaboration compared to the use of Minecraft: Education Edition.

Normality and Homogeneity Tests

Before conducting a comparative analysis between the experimental and control groups, normality and homogeneity tests were carried out to ensure the appropriateness of using parametric tests. The results of the Shapiro-Wilk normality test are shown in the table below.

Table 3. Normality Test (Shapiro-Wilk)

Group	Variable	Statistic	df	Sig. (p-value)
Experiment	Pretest Concept	0.961	24	0.432
Experiment	Posttest Concept	0.953	24	0.295
Experiment	Pretest Collaboration	0.964	24	0.486
Experiment	Posttest Collaboration	0.958	24	0.387
Control	Pretest Concept	0.967	24	0.556
Control	Posttest Concept	0.950	24	0.267
Control	Pretest Collaboration	0.973	24	0.715
Control	Posttest Collaboration	0.962	24	0.472

Based on the Shapiro-Wilk test results above, all Sig. (p-value) values for each variable in both groups are greater than 0.05. This indicates that the pretest and posttest data for both conceptual understanding and collaboration variables are normally distributed.

Table 4. Homogeneity Test (Levene's)

Variable	Levene Statistic	df1	df2	Sig. (p-value)
Pretest Concept	0.216	1	46	0.644
Posttest Concept	1.732	1	46	0.195
Pretest Collaboration	0.127	1	46	0.723
Posttest Collaboration	1.438	1	46	0.237

Based on the table above, the significance values (Sig.) of all variables are greater than 0.05, indicating that there are no significant differences in variances between the experimental and control groups. In other words, the data from both groups have homogeneous or equal variances.

MANOVA Test

Multivariate Analysis of Variance (MANOVA) serves as a robust statistical method for assessing mean differences across two or more groups, considering multiple dependent variables concurrently. Its core objective is to maximize the differentiation between these groups by forming linear combinations of quantitative variables. In the context of this investigation, the null hypothesis (H_0) posits no statistically significant disparity between the experimental and control groups concerning their conceptual understanding and collaboration proficiencies. Conversely, the alternative hypothesis (H_1) proposes a significant distinction. The criterion for decision-making dictates that if the significance value (Sig.) falls below 0.05, the null hypothesis (H_0) is rejected, thereby indicating a notable effect;

otherwise, H_0 is retained. The outcomes of the MANOVA test are presented in the subsequent table.

Table 5. MANOVA Tests Results

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.999	16360.239[b]	2.000	45.000	.000
	Wilks' Lambda	.001	16360.239[b]	2.000	45.000	.000
	Hotelling's Trace	727.122	16360.239[b]	2.000	45.000	.000
	Roy's Largest Root	727.122	16360.239[b]	2.000	45.000	.000
Class	Pillai's Trace	.948	410.679[b]	2.000	45.000	.000
	Wilks' Lambda	.052	410.679[b]	2.000	45.000	.000
	Hotelling's Trace	18.252	410.679[b]	2.000	45.000	.000
	Roy's Largest Root	18.252	410.679[b]	2.000	45.000	.000

a. Design: Intercept + Class

b. Exact statistic

Based on the multivariate test results presented in Table 5, the instructional method (Class) had a statistically significant multivariate effect on the combined dependent variables: conceptual understanding and collaboration skills (Wilks' Lambda = .052, $F(2, 45) = 410.679$, $p < .001$). All four multivariate criteria (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root) consistently indicated a significant impact. This confirms that the variation in learning outcomes is strongly associated with the use of different instructional media, particularly Minecraft: Education Edition. These results provide a foundation for further analysis using the Between-Subjects Effects test to determine the specific contribution of the instructional method to each dependent variable.

Table 6. Between-Subjects Effects Test

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Conceptual Understanding	3383.521[a]	1	3383.521	521.486	.000
	Collaboration Skills	800.333[b]	1	800.333	830.421	.000
Intercept	Conceptual Understanding	216411.021	1	216411.021	33354.428	.000
	Collaboration Skills	14981.333	1	14981.333	15544.541	.000
Class	Conceptual Understanding	3383.521	1	3383.521	521.486	.000
	Collaboration Skills	800.333	1	800.333	830.421	.000

Error	Conceptual Understanding	298.458	46	6.488
	Collaboration Skills	44.333	46	.964
Total	Conceptual Understanding	220093.000	48	
	Collaboration Skills	15826.000	48	
Corrected Total	Conceptual Understanding	3681.979	47	
	Collaboration Skills	844.667	47	
a. R Squared = .919 (Adjusted R Squared = .917)				
b. R Squared = .948 (Adjusted R Squared = .946)				

Table 6 presents the results of the Between-Subjects Effects test, which further examines the influence of the instructional method on each dependent variable. The analysis shows that the class variable, representing the use of Minecraft: Education Edition, had a statistically significant effect on both conceptual understanding ($F(1, 46) = 521.486$, $p < .001$) and collaboration skills ($F(1, 46) = 830.421$, $p < .001$). The R^2 values indicate that 91.9% of the variance in conceptual understanding and 94.8% of the variance in collaboration skills can be explained by the learning method. These findings confirm that Minecraft: Education Edition is highly effective not only in enhancing students' cognitive performance but also in strengthening their collaborative abilities. The results support the integration of interactive and student-centered digital tools in IPAS learning to achieve more comprehensive educational outcomes.

Discussion

The findings of this study indicate that the integration of Minecraft: Education Edition in the IPAS (Science and Social Studies) learning process has a significant influence on improving both conceptual understanding and collaboration skills of elementary school students. This reinforces the premise that interactive digital tools can serve not merely as learning supplements, but as transformative media that align with the characteristics and needs of 21st-century learners.

Compared to the control group receiving conventional instruction, students in the experimental group exhibited not only a higher posttest mean score in conceptual understanding, but also greater gains in collaboration. These results demonstrate that Minecraft's open-ended, visual, and exploratory features facilitate active learning, allowing students to build and internalize concepts through direct engagement, peer interaction, and creative construction. This is consistent with previous research byKarsenti & Bugmann (2017), who found that game-based environments can foster cognitive development while simultaneously enhancing students' interpersonal competencies.

In line with Evi et al. (2024), who argued that generative learning supported by digital platforms promotes higher-order thinking skills, this study illustrates how Minecraft enables learners to explore, test, and refine ideas collaboratively. Its mechanics, which encourage autonomy and experimentation, mirror real-world

problem-solving contexts—making the learning process not only meaningful but also relevant to students' lived experiences.

Moreover, the significant effect sizes identified in this study ($R^2 = 0.919$ for conceptual understanding and $R^2 = 0.948$ for collaboration) affirm the pedagogical potential of digital game-based learning, particularly in fostering deeper engagement and sustainable learning outcomes. These findings are also aligned with the vision of Merdeka Belajar, which emphasizes learner-centered approaches, creativity, contextualization, and the use of technology to support holistic education (Hunaepi & I Gusti Putu Suharta, 2024; OECD, 2023).

This study also contributes practically to instructional design. Educators can take advantage of digital sandbox tools like Minecraft not only to deliver content, but to cultivate soft skills such as communication, teamwork, and self-directed learning. When students are involved in creating virtual models, negotiating roles, and reflecting on tasks, they are actively constructing knowledge within a socially meaningful context, in line with constructivist learning theory (Ardiansyah & Ujihanti, 2017; Kurt, 2021; Zajda, 2021).

In conclusion, Minecraft: Education Edition proves to be more than a recreational platform—it is a powerful educational medium that bridges cognitive learning with collaborative skill development. Educational institutions and policymakers are encouraged to embrace and integrate such tools into formal curricula as part of a broader strategy to achieve future-ready education, especially in elementary learning environments where foundational skills are being built.

CONCLUSION

The integration of Minecraft: Education Edition into IPAS (Science and Social Studies) learning significantly enhances students' conceptual understanding and collaboration skills, as evidenced by the strong effect sizes in this study. Rather than serving merely as a digital supplement, Minecraft functions as a transformative medium that aligns with the principles of constructivist learning and the demands of 21st-century education. The interactive, exploratory, and collaborative nature of the platform fosters not only cognitive development but also key socio-emotional competencies, making it highly relevant in the context of Indonesia's Merdeka Belajar vision. These findings imply that educational games, when thoughtfully implemented, can play a strategic role in reshaping instructional practices toward more student-centered, engaging, and skill-oriented approaches. Therefore, educators and policymakers are encouraged to explore the broader integration of digital game-based learning environments to support holistic student development, particularly at the elementary level where foundational learning attitudes are formed.

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