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Implementation of Game-Based Assessment Media 'SPEDU' to Measure Conceptual Understanding of Ecology and Biodiversity among 7th Grade Junior High School Students in Yogyakarta

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ABSTRACT
This study aims to describe the effectiveness of using the game-based assessment media "SPEDU" (Spinner Education) in measuring and improving students' conceptual understanding of ecology and biodiversity material among seventh-grade students at a public junior high school in Yogyakarta. The research method employed in this study is descriptive quantitative with a pre-experimental approach, using a one-group pretest-posttest design. The implementation of the SPEDU media improved students' conceptual understanding, with an average posttest score of 8.00. This indicates that the application of SPEDU had a positive effect in enhancing students' conceptual understanding of ecology and biodiversity. The standard deviation results also showed that the posttest scores were more homogeneous compared to the pretest scores, suggesting that SPEDU was effective in improving students' understanding more evenly across the class in this subject matter. In addition, N-gain analysis indicated that the N-gain score for the ecology and biodiversity content was in the high category (0.86). The results of the Paired Sample t-Test analysis also indicated a significant difference between the pretest and posttest scores, confirming that the use of SPEDU had a significant impact on improving students' conceptual understanding. Therefore, SPEDU is effective as an engaging and enjoyable learning tool that encourages students to develop a deeper understanding of ecological and biodiversity concepts.

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1. INTRODUCTION

Conceptual understanding, the ability to internalize and apply information from various experiences (Susanti et al., 2021), is crucial for learning success, enabling students to explain concepts in their own words (Lestari et al., 2024). Science aims to develop knowledge and understanding of useful scientific concepts that can be applied in daily life. Therefore, science education focuses on developing understanding and knowledge that are relevant to practical needs in everyday life.

Science education, particularly at the junior high level, strategically builds this understanding of natural phenomena, fostering critical thinking and environmental awareness (Yuliana et al., 2022; Nurhasanah & Prasetyo, 2021). Therefore, conceptual understanding becomes a vital aspect of science learning. It is not merely about memorizing information but requires students to connect, explain, and apply the concepts they have learned to various situations (Nurhasanah & Prasetyo, 2021).

One of the essential topics in science education that plays a significant role in forming students' conceptual understanding is ecology and biodiversity. This topic provides insights into the relationships between living organisms and their environment while also instilling an awareness of the importance of maintaining ecosystem balance. Within ecology and biodiversity, there are subtopics such as food chains and the interactions of living organisms in ecosystems that play a key role in shaping students' conceptual understanding. The food chain topic helps students understand the flow of energy between living organisms through the process of consumption, from producers to apex consumers. Meanwhile, the discussion on interactions among living organisms in ecosystems, such as predation, competition, and symbiosis, provides concrete examples of how each organism depends on and influences the environmental balance. By studying these two subtopics, students not only gain theoretical

knowledge but can also relate the concepts to natural phenomena occurring around them, such as the importance of maintaining the population of certain animals or the impact of the breakdown of a food chain in an ecosystem. This aligns with the goal of science education, which is to develop applicable and relevant understanding for daily life.

Ecology and biodiversity are essential topics for developing this understanding, providing insights into the relationships between organisms and their environment, and promoting awareness of ecosystem balance. Key subtopics include food chains and interactions among organisms, which help students connect theoretical knowledge to real-world phenomena. However, science teachers at SMPN 1 Yogyakarta have indicated that they spend a disproportionate amount of time re-teaching basic ecology concepts due to students' difficulty retaining the information from traditional lectures. This is corroborated by an analysis of student worksheets and past exam papers, which revealed a recurring pattern of errors in questions related to symbiotic relationships, suggesting a superficial understanding of these interactions. Ecology and biodiversity are directly related to students' experiences, yet many struggle with abstract concepts like interactions and food chains (Wahyuni et al., 2023). Although studies have explored the use of educational games to enhance the learning experience, there is a noticeable research gap in the integration of game-based media specifically designed to assess students' conceptual understanding in science topics such as ecology and biodiversity. To address this gap, this research focuses on developing and implementing “SPEDU” (Spinner Education), a spinner wheel-based game inspired by "wheel of fortune" (Pratiwi, 2023), to assess students’ conceptual understanding of these topics. SPEDU contains information on food chain levels and ecosystem interactions, enhancing engagement and enabling formative assessment (Mulyani & Hidayat, 2025).

This research addresses the problem of how to design and implement a game-based assessment medium that can effectively measure students’ conceptual understanding of ecology and biodiversity. The primary research question is: How effective is the “SPEDU” (Spinner Education) game-based assessment media in improving seventh-grade students’ conceptual understanding of ecology and biodiversity at a public junior high school in Yogyakarta? This research aims to describe the design and implementation of the “SPEDU” game-based assessment media in ecology and biodiversity learning and analyze the effectiveness of the “SPEDU” media in improving students’ conceptual understanding of ecology and biodiversity among seventh-grade students at a public junior high school in Yogyakarta."

2. RESEARCH METHOD

This research is a quantitative study with a pre-experimental approach, employing a one-group pretest-posttest design. This design was used to determine the effectiveness of implementing the game-based assessment media “SPEDU” in improving students’ conceptual understanding of the Ecology and Biodiversity material. The sample in this study consisted of all students in Class VII B at a public junior high school in Yogyakarta City. This class was selected because the students had previously received the Ecology and Biodiversity material through conventional learning methods, allowing for a more focused evaluation of the impact of the SPEDU-based assessment media. The instrument used in this study consisted of 20 multiple-choice questions designed to measure students’ conceptual understanding of ecology and biodiversity material, aligned with specific indicators of conceptual understanding. The questions were empirically tested to determine their validity and reliability.

The validity and reliability of the test instruments were determined through an empirical testing process. The validity of each item was analyzed using the Pearson Product-Moment correlation, and items with a correlation coefficient (r-count) higher than the r-table value (r-hitung > r-tabel) at a 5% significance level were considered valid. The reliability of the instrument was tested using Cronbach’s Alpha, resulting in a coefficient value above 0.70, indicating that the instrument was reliable. In addition, content validity was also ensured through expert judgment involving two lecturers in science education and one junior high school science teacher.

The data collection technique in this study was carried out through tests consisting of a pretest and a posttest. The test items were objectively constructed and developed based on indicators of conceptual understanding. The test instrument was designed according to the conceptual understanding indicators proposed by Anderson & Krathwohl (in Suryani, 2019:4–5), which include (1) interpreting, which refers to students' ability to understand the meaning of a concept or information; (2) exemplifying, the ability to mention concrete examples of a concept; (3) classifying, the ability to group objects or information into the appropriate category; (4) summarizing, the ability to present information briefly and concisely; (5) inferring, the ability to draw conclusions from given data or statements; (6) comparing, the ability to identify similarities and differences between two concepts or objects; and (7) explaining, the ability to provide logical explanations of a process or the relationships between concepts. The test was answered by students using Google Forms. The data obtained from the pretest and posttest results were analyzed quantitatively using descriptive statistics, which serve to determine the mean, minimum and maximum values, and standard deviation of the pretest and posttest scores. The Paired Sample t-Test was conducted to identify whether there was a significant difference between the pretest and posttest scores. In addition, the N-gain calculation was used to measure the extent of improvement in conceptual understanding after the treatment, as presented in Table 1.

Table 1. N-gain Criteria

Value Interval	Kriteria
N-gain . 1.0	High
0.3 ≤ N-gain < 0.7	Medium
N-gain < 0.3	Low

3. RESULT AND DISCUSSION

This study analyzes pretest and posttest data to evaluate the effectiveness of the "SPEDU" game-based assessment media in improving students' conceptual understanding of Ecology and Biodiversity material. The data analyzed includes the mean, standard deviation, N-gain, distribution of pretest and posttest data, as well as determining whether there is a significant difference between the pretest and posttest scores. Descriptive statistics were used to calculate the mean, standard deviation, and overall N-gain. Additionally, N-gain analysis was conducted for each indicator of creative thinking skills to assess the improvement in each aspect of understanding. The Shapiro-Wilk normality test was employed to examine the distribution of pretest and posttest data, while the Paired Sample t-test was used to determine whether there was a significant difference between the pretest and posttest scores.

Based on Table 2, which presents the descriptive statistics, the average pretest score is 5.85, while the average posttest score is 8.00. This increase in the average score indicates that the SPEDU game-based assessment media has a positive impact on students' conceptual understanding of ecology and biodiversity. Additionally, the standard deviation for the posttest is 2.961, which is higher than the pretest's standard deviation of 2.670, suggesting that while there is an improvement, the distribution of posttest scores is more variable compared to the pretest. These findings align with the study by Ulum et al (2025), which utilized the "Roll Spinner" media in IPAS learning. The study found that the use of game-based learning media significantly improved students' creative thinking abilities. Previous studies show consistency in the results obtained, despite differences in context and subject matter. This indicates that the implementation of game-based assessment media, such as SPEDU, holds significant potential in enhancing conceptual understanding across various educational fields.

Table 2. Descriptive Statistics

	Descriptive Statistics				
	N	**Minimum**	**Maximum**	**Mean**	**Std. Devitation**
Pretest	27	1	11	5.85	2.670
Posttest	27	3	16	8.00	2.961

Based on Table 3, the N-Gain analysis shows that the N-Gain score obtained by the experimental class is 0.86, which falls into the high category. This indicates that the implementation of the SPEDU game-based assessment media has had a strong impact on improving students' conceptual understanding of ecology and biodiversity. With a total of 27 students, the N-Gain analysis demonstrates that the majority of students experienced significant improvement in their understanding after the intervention. These findings reinforce that SPEDU is effective both as an assessment tool and as a meaningful learning medium. This result is in line with the findings of Nuryani et al (2022), which suggest that the use of game-based media can significantly enhance students' creative thinking skills.

Table 3. Results of N-gain of Students Concept Understanding

Class	N	N-Gain	Description
Experiment	27	0.86	High

Based on Table 4, the N-Gain analysis indicates that all indicators of conceptual understanding according to Anderson & Krathwohl showed improvement categorized as medium to high. The indicator with the highest N-Gain is "Explaining" with a score of 0.80, classified in the high category, suggesting that the SPEDU game-based assessment media is highly effective in encouraging students to understand and explain concepts in depth. This is followed by the "Comparing" indicator with an N-Gain of 0.79, also showing significant improvement. However, the indicator with the lowest N-Gain is "Interpreting," with a score of 0.33, which falls into the medium category. Although there was overall improvement in students' conceptual understanding, this finding suggests that this indicator may require more targeted teaching approaches to achieve more optimal results. This is

supported by the findings of Ulum et al (2025), which demonstrated that the use of the "Spinner" media effectively enhances students' creative thinking skills. Their results indicate that game-based media can strengthen students' ability to process and explain information clearly, which aligns with the improvement in N-Gain for the "Explaining" indicator in this study.

Table 4. Result of N-Gain Analysis of Each Indicator of Creative Thinking Skills

No	Indicator	Numbers of Questions	N-Gain	Category
1.	Interpreting	3	0.33	Medium
2.	Exemplifying	3	0.41	Medium
3.	Classifying	3	0.60	Medium
4.	Summarizing	3	0.30	Medium
5.	Inferring	3	0.43	Medium
6.	Comparing	2	0.79	High
7.	Explaining	3	0.80	High

Based on Table 5, the results of the normality test using the Shapiro-Wilk method show that the significance (Sig.) value for the pretest was 0.464, and for the posttest was 0.508. Both values are greater than 0.05, indicating that the pretest and posttest data are normally distributed. Therefore, the assumption of normality is met, and the data are suitable for further analysis using parametric statistical tests, such as the paired sample t-test.

Table 5. Shapiro-Wilk Pretest Posttest Normality Test Analysis Result

Class	Shapiro-Wilk		
	Statistic	df	Sig.
Pretest	.964	27	.464
Posttest	.966	27	.508

Based on Table 6, the results of the Paired Sample t-Test analysis indicate a significant difference between the pretest and posttest scores. The mean pretest score was 5.85 with a standard deviation of 2.670, while the mean posttest score was 8.00 with a standard deviation of 2.961. The standard error mean for the pretest was 0.514, and for the posttest, it was 0.570. These results suggest that the implementation of the SPEDU game-based assessment media has positively impacted students' conceptual understanding, as evidenced by the higher posttest scores compared to the pretest scores.

Table 6. Analysis Results of Paired Sample T-test

Class	Paired Differences		Std. Error Mean
	Mean	Std.Deviation	
Pretest	5.85	2.670	.514
Posttest	8.00	2.961	.570

The research findings were obtained from the SPEDU game-based assessment, using a conceptual understanding test instrument that had been aligned with the seven indicators of conceptual understanding. The research subjects consisted of all 27 students from Class VII B at a junior high school in Yogyakarta. The game-based assessment developed in this study covered the material on ecology and biodiversity and was named SPEDU. Through the SPEDU game, students were challenged to identify types of living organisms and their roles within an ecosystem, after which they were guided to complete LKPD (student worksheets) in groups. In addition, after completing the LKPD, students also answered individual test questions. Finally, a posttest was administered to determine the extent of students' conceptual understanding of the ecology and biodiversity material. The display of the SPEDU game-based assessment is presented in Figure 1.

Figure 1. SPEDU

Based on the results of the descriptive statistical analysis, it was found that there was an increase in the average score following the implementation of the SPEDU media, with a posttest average of 8.00. This indicates that the application of SPEDU had a positive effect in enhancing students' conceptual understanding of ecology and biodiversity. The standard deviation results also showed that the posttest scores were more homogeneous compared to the pretest scores, suggesting that SPEDU was effective in improving students' understanding more evenly across the class in this subject matter. This finding is consistent with a study by Fitria et al (2022) which also reported an improvement in students' conceptual understanding after the use of spin game media, attributed to the learning process being more enjoyable and engaging, which encouraged students to better comprehend the material. Furthermore, N-gain analysis was conducted to determine the category of improvement in students' average conceptual understanding. The results indicated that the N-gain score was in the high category for the ecology and biodiversity content. To gain a deeper insight into students' conceptual understanding of the topic, an analysis was also carried out on each indicator of conceptual understanding.

The interpreting indicator in the SPEDU media appeared during the process of linking animals or plants within a food chain. The N-gain score for this indicator was 0.33, categorized as medium. Next, the exemplifying indicator was observed during the activity in which students provided examples of animals or plants that matched the type or role indicated by the SPEDU columns. This indicator showed an N-gain score of 0.41, also in the medium category. The classifying indicator was reflected in students' ability to categorize types or roles of animals or plants shown in SPEDU within an ecosystem. This indicator also fell into the medium category, with an N-gain score of 0.60. The next indicator, summarizing, involved students summarizing the answers they obtained from SPEDU results. This indicator had the lowest N-gain score of 0.30, though it still belonged to the medium category. However, it suggests the need for a more targeted approach by educators. This finding indicates a lack of practice in filtering essential information and reorganizing it into a more concise form. This aligns with the view of Sonia et al (2023) who stated that the summarizing indicator requires additional instructional support to train students in selecting important information and expressing it in a clearer and more concise manner.

The inferring indicator was carried out during the final stage of the learning process, in which students drew conclusions from the answers obtained through the SPEDU media. This indicator achieved an N-gain score of 0.43, categorized as medium. The comparing indicator showed an N-gain score of 0.79, within the high category. The explaining indicator occurred when students provided further explanations regarding the roles and types of animals or plants displayed in the SPEDU media. This indicator recorded the highest N-gain score of 0.80, making it the most prominent among all indicators. This is in line with the view of Janah & Hidayati (2020) who stated that the explaining indicator involves a deep understanding of the relationships among components within a system. This indicator recorded the highest N-gain score of 2.30, making it the most prominent among all indicators. This suggests that students were able to understand the ecology and biodiversity material effectively, as demonstrated by their ability to explain the types and roles of organisms presented through the SPEDU media.

Subsequently, a normality test was conducted using the Shapiro-Wilk method. The results showed that the significance values for both the pretest and posttest were greater than 0.05, indicating that the data were normally distributed. Therefore, the assumption of normality was met, and the data were suitable for further analysis using a paired sample t-test. The analysis results revealed a significant difference between the pretest and posttest scores, with a mean difference of -2.15, indicating that the average posttest score was higher than the average pretest

score. Based on these findings, it can be concluded that the implementation of the SPEDU assessment media had a significant effect on improving students' conceptual understanding of the ecology and biodiversity material.

4. CONCLUSION

Based on the research findings and analysis, it can be concluded that the implementation of the SPEDU game-based assessment media has been proven effective in enhancing students' conceptual understanding of ecology and biodiversity material. This is evidenced by an increase in the average posttest score of 8.00, as well as the N-gain analysis, which showed that the overall N-gain score was in the high category, 0.86. Furthermore, the analysis of each indicator of conceptual understanding revealed improvements in most indicators, with the "Explaining" indicator achieving the highest N-gain score of 0.80. In addition, the results of the paired sample t-test revealed a significant difference between the pretest and posttest scores, confirming that the use of the SPEDU game-based assessment media had a tangible impact on improving students' conceptual understanding of ecology and biodiversity material. Therefore, SPEDU is effective as an engaging and enjoyable learning tool that motivates students to develop a deeper understanding of ecological and biodiversity concepts.

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