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The Effect of the Guided Inquiry Model with Wordwall-Based Assessment on Students' Learning Outcomes and Science Process Skills

Vaneyda Salsabilla Evanda Zenum, Wiwi Isnaeni[1] ✉

[1]Departement of Biology, Faculty of Mathematics and Natural Sciences, Semarang State University, Indonesia

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Abstract

This study examined the effect of the guided inquiry learning model integrated with Wordwall-based assessment on students' learning outcomes and science process skills (SPS). A quasi-experimental method with a post-test only control group design was employed. The research focused on biodiversity content and was conducted at SMA Negeri 10 Semarang. Data were collected through tests, questionnaires, observations, and documentation. The research instruments included a post-test, SPS questionnaire, student worksheets (LKPD), SPS observation sheets, and a learning implementation observation sheet. The results showed that students in the experimental class achieved significantly higher cognitive learning outcomes (mean = 91) than those in the control class (mean = 69; $\rho < 0.001$). In addition, students' science process skills in the experimental class were significantly higher (mean = 100) compared to the control class (mean = 85; $p < 0.001$), supported by worksheet and observational data. Furthermore, a strong positive correlation was found between science process skills and learning outcomes ($\rho = 0.635$), with SPS contributing 40.32% to the variance in learning outcomes.In conclusion, the integration of the guided inquiry model with Wordwall-based assessment has a positive and significant effect on enhancing students' learning outcomes and science process skills. This approach can be considered an innovative alternative for biology instruction that emphasizes scientific skills and conceptual understanding.

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✉**Correspondence Address:**
D6 Building, Faculty of Mathematics and Natural Sciences (FMIPA), Sekaran, Gunungpati, Semarang, 50229

E-mail: wiwiisna@mail.unnes.ac.id

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INTRODUCTION

The biology learning process in the *Merdeka Curriculum* is implemented through contextual and inquiry-based approaches, thereby making learning more student-centered rather than teacher-centered. One of the biology topics that requires such competencies is biodiversity. This topic encourages students to actively engage in scientific activities, not merely receiving information passively but being directly involved in the scientific process (Sugiyono, 2013). Learning that emphasizes students' active involvement in scientific activities therefore requires assessment methods that are able to measure not only students' learning outcomes (Suriyani et al., 2020).

Assessment is one of the essential components in biology learning, as it is used to evaluate the achievement of students' competencies (Karnama, 2020). Assessment and learning are closely interconnected. Well-designed assessments that are engaging, interactive, and aligned with students' characteristics can enhance learning motivation, encourage active student participation, and ultimately improve learning outcomes. (Ismail et al., 2022).

Observational results in Grade X at SMA Negeri 10 Semarang indicate that biology instruction remains predominantly teacher-centered, relying mainly on lecture-based methods and textbook use. The assessments employed are limited to paper-based written tests or online tests administered through Google Forms. As a result, students tend to be less active during the learning process and are rarely engaged in activities such as observation, discussion, problem formulation, and problem solving. Consequently, students' science process skills have not developed optimally. This condition leads to suboptimal conceptual understanding of biodiversity topics, and students' learning outcomes have not yet met the expected objectives. This situation is reflected in the results of daily assessments, where 55.5% of students did not achieve the minimum mastery criteria (KKM). Based on these conditions, there is a need for an engaging learning model and assessment tools as alternative approaches to the teaching and learning process.

Engaging and interactive assessment is essential to improve students' learning outcomes. Wordwall is a web-based digital gamification learning application that provides various games and quizzes to support teachers in conducting instructional activities while simultaneously assessing students' abilities through a more appealing interface (Aryani et al., 2021a). Previous studies have reported that the use of Wordwall as an assessment or evaluation tool can serve as an alternative for teachers to measure students' understanding of learning materials in an attractive and interactive manner (Aryani et al., 2021b).

earning on biodiversity topics requires a student-centered learning model to actively engage students in understanding concepts and developing science process skills. One learning model that can be applied is guided inquiry(Adawiyah, 2018). The guided inquiry learning model requires students to identify and solve problems through structured guidance provided by the teacher(Budiarti et al., 2016). This model positions students as active subjects in the learning process, encouraging them to participate more actively in classroom activities(Amijaya et al., 2018). Learning activities in guided inquiry include problem orientation, hypothesis formulation, investigation, data analysis, and communication of results, which provide students with authentic learning experiences (Nurlina, 2020). Furthermore, the syntax of the guided inquiry model is aligned with the indicators of science process skills, thereby supporting the improvement of the expected competencies (Erlina et al., 2022).

Science process skills serve as an essential foundation for enhancing students' understanding of biodiversity concepts, as this topic requires direct investigative activities in real-world environments(Sudarmi et al., 2024). Previous studies have shown that contextual approaches, such as direct environmental observation, are effective in improving science process skills, particularly in students' abilities to communicate findings and draw conclusions (Hernawati & Diah Ika Putri, 2020).

Based on these considerations, it is necessary to conduct research on the effects of learning outcomes and science process skills through the implementation of the guided inquiry learning model combined with Wordwall-based assessment. This study aims to determine the extent to which this approach influences students' learning outcomes and science process skills in biodiversity learning, so that it can be utilized as an alternative strategy to support the implementation of biology instruction in the classroom.

RESEARCH METHODOLOGY

This study was conducted at SMA Negeri 10 Semarang during the odd semester of the 2023/2024 academic year. The research employed a quantitative approach using a quasi-experimental design. The design applied was a post-test only control group design, involving two groups: a control class and an experimental class. The population of this study consisted of all Grade X students, from which samples were selected using purposive sampling. Based on teachers' recommendations and considerations, Class X-6 was assigned as the control group with 36 students, while Class X-5 was designated as the experimental group with 35 students. Data were collected through tests, questionnaires, observations, and documentation. The research instruments included a post-test, a science process skills (SPS) questionnaire, student worksheets (LKPD), SPS observation sheets, and a learning implementation observation sheet. The data analysis techniques comprised descriptive statistical analysis of post-test learning outcomes, descriptive statistical analysis of SPS questionnaire results, descriptive statistical analysis of observational data and group worksheet results, non-parametric inferential statistical analysis using the Mann–Whitney U test, and correlation analysis using Spearman's rank correlation.

RESULTS AND DISCUSSION

The results of this study focused on three main aspects: students' learning outcomes, students' science process skills (SPS), and the relationship between learning outcomes and SPS in the implementation of the guided inquiry learning model combined with Wordwall-based assessment. These three aspects were analyzed separately based on the instruments and data that had been developed, in order to determine the effect of the guided inquiry model and the Wordwall assessment tool on each of these variables.

The Impact of Guided Inquiry and Wordwall on Students' Learning Outcomes

The results indicate that the learning outcomes of students in the experimental class were higher than those in the control class, as presented in Table 1.

Table 1. Descriptive Analysis of Students' Learning Outcomes Data

Group	N	Score Min	Score Max	Mean	Std. Dev.
Control	36	22	92	69	19,6
Experiment	35	70	100	91	8,7

As presented in Table 1, the post-test results showed that the experimental class achieved a higher mean score (91) compared to the control class (69). This indicates that the average learning outcomes of students in the experimental class were higher than those in the control class. The mean difference of 22 points demonstrates that the implementation of the guided inquiry learning model combined with Wordwall-based assessment had a substantial effect on improving students' cognitive learning outcomes (Marsyandha et al., 2024).

The Mann–Whitney U test was employed to determine differences between the two groups due to the data not being normally distributed(Normelia et al., 2022). The test yielded a significance value of 0.000,

indicating a p-value < 0.001. This result confirms a statistically significant difference between the experimental class that received the treatment and the control class. Based on these findings, it can be concluded that the guided inquiry model with Wordwall-based assessment significantly influenced students' cognitive learning outcomes (Anggraini et al., 2022)

Differences in learning processes account for the substantial disparity in average scores between the experimental and control classes. Students in the experimental class engaged in learning activities that guided them to formulate problems, design investigations, collect and analyze data, and draw conclusions independently. These activities encourage students to think critically, connect concepts to real-life contexts, and actively construct knowledge rather than passively receive information (Mulyati et al., 2023). Learning outcomes are used to identify changes in students' abilities and behaviors following the teaching and learning process, encompassing the cognitive, affective, and psychomotor domains, and are measured through assessment instruments.

The use of web-based applications as assessment tools provides a more interactive and engaging learning experience(Andrian et al., 2022). Wordwall offers features with visually appealing displays, diverse game designs, and a high level of interactivity, thereby creating a more enjoyable learning environment (Indriani et al., 2025) Students are not limited to completing conventional multiple-choice or matching questions; instead, they engage in educational game-based formats that enhance learning motivation, increase student involvement, and optimize conceptual understanding (Zedri et al., 2025)

In contrast, the control class implemented conventional instruction through lecture-based methods and paper-based exercises, which tended to be more teacher-centered than student-centered. This approach provided limited opportunities for active student engagement and higher-order thinking, resulting in conceptual understanding that remained at the memorization level, making previously learned material more easily forgotten (Faiz et al., 2024). These differences are reflected in the lower average post-test scores of the control class compared to the experimental class. The significant difference in outcomes between the two classes indicates that student-centered learning models combined with interactive assessment tools are more effective in improving students' learning outcomes(Putriani et al., 2025).

Based on the discussion above, it can be concluded that the guided inquiry model and Wordwall-based assessment have a significant effect on students' learning outcomes. Furthermore, the integration of this learning model and assessment approach contributes to the improvement of students' learning outcomes.

The Effect of Guided Inquiry and Wordwall-Based Assessment on Students' Science Process Skills

This study indicates that the science process skills of students in the experimental class were higher than those of students in the control class. Data on science process skills (SPS) were obtained through questionnaires administered to 36 students in the control class and 35 students in the experimental class. The data were analyzed descriptively to determine the mean, standard deviation, minimum score, and maximum score achieved by the students. The results are presented in Table 2.

Table 2. Descriptive Analysis of Students' Science Process Skills

Group	N	Mean KPS	Std. Deviasi	Score Min	Score Max
Control	36	85	16,59	46	103
Experiment	35	100	14,32	64	115

Table 2 shows that the average (mean) science process skills (SPS) score of students in the control class was approximately 85 with a standard deviation of 16.59, whereas students in the experimental class achieved a higher mean score of 100 with a standard deviation of 14.32. The mean SPS score of students in the experimental class was higher than that of the control class. In addition, the score range in the experimental class tended to be higher. These results indicate that students in the experimental class demonstrated higher levels of science process skills than those in the control class.

The Mann–Whitney test was conducted to determine whether there were differences in students' science process skills between the control and experimental classes (Aulia Rahman et al., 2020). S Prior to this analysis, normality and homogeneity tests were performed (Novianti et al., 2021). The SPS questionnaire data were not normally distributed; however, the variance between the two groups was homogeneous. Therefore, a non-parametric analysis using the Mann–Whitney test was applied. The test results yielded a significance value of 0.000 ($p < 0.001$), indicating a statistically significant difference between the control and experimental classes (Sugiyono, 2013).

This significant difference confirms that the guided inquiry model combined with Wordwall-based assessment has a positive effect on students' science process skills competence (Yumniya & Handayani, 2025) This learning model enhances science process skills more effectively than conventional instruction. This effect can be attributed to the syntax of guided inquiry learning, which is aligned with science process skills competencies (Daudi & Wulandari, 2025). Each phase of guided inquiry learning—orientation, problem formulation, hypothesis formulation, data collection, hypothesis testing, and drawing conclusions—systematically trains science process skills components, including observing, classifying, measuring, predicting, concluding, and communicating.

During the learning activities, environmental observations were conducted in both classes to identify the levels of flora diversity surrounding the school environment. These activities were carried out in groups. The student worksheets (LKPD) contained instructions and tables to be completed for identifying levels of biodiversity in the school environment. In addition, the worksheets included questions and tables related to ecosystem types, fauna distribution, the benefits of biodiversity, and group discussions. The comparison of students' worksheet scores between the control and experimental classes is presented in Figure 1.

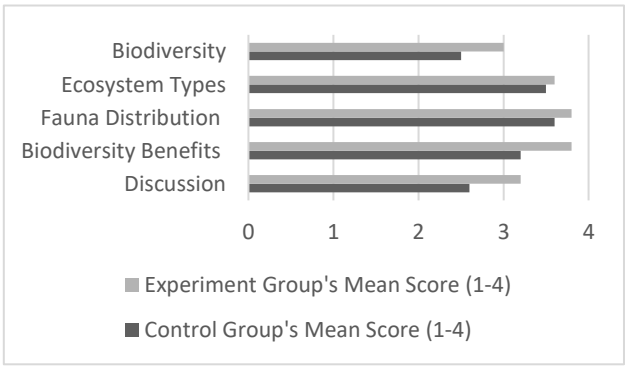

Figure 1. Students' Content Mastery Scores Based on LKPD in the Control and Experimental Classes

The average scores obtained from the analysis of the student worksheets indicate that the experimental class outperformed the control class. A significant difference was observed between the two groups, with students in the experimental class achieving higher mean scores across all assessed aspects. The mean score differences ranged from 1.0 to 1.5 points compared to the control class. One of the key aspects assessed in this activity was the identification of biodiversity levels. In this aspect, students were required to

conduct environmental observations around the school area (Hasanah et al., 2024). Each group identified local flora in the surrounding environment and recorded their findings in an observation table. After data collection, students identified the levels of biodiversity, including genetic and species diversity. The identification process is essential as a fundamental skill in scientific observation. Students in the experimental class demonstrated higher proficiency in applying science process skills, as they had been systematically trained through the stages of guided inquiry prior to conducting environmental observations (Nurlatifah & Supihatiningrum, 2023).

Biodiversity learning fundamentally requires the mastery of science process skills (Ariyansyah & Nurfathurramah, 2022). In the Merdeka Curriculum, the learning outcomes for biodiversity content require students to observe biodiversity phenomena in real environments, classify flora and fauna based on biodiversity levels (genetic, species, and ecosystem), identify species and their characteristics, and analyze distribution patterns as well as the benefits of biodiversity (Hernawati & Diah Ika Putri, 2020). Previous studies have demonstrated that biodiversity content is highly dependent on science process skills due to its contextual and authentic nature, in which students are not passive recipients of information but are actively involved in scientific activities such as field observations, organism classification, and drawing conclusions (Sudarmi et al., 2024). Therefore, biodiversity learning within the Merdeka Curriculum aims not only to develop conceptual understanding but also to enhance students' science process skills through authentic learning experiences oriented toward environmental problem-solving (Hernawati & Diah Ika Putri, 2020)

The results of the group observation sheets further strengthened the findings related to students' science process skills. Observations were conducted directly during the learning activities. The analysis of the observation sheets is presented in Figure 2.

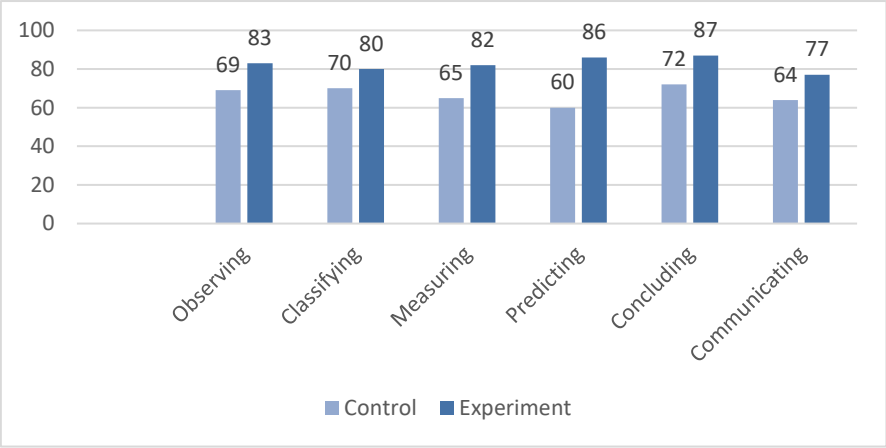

Figure 2. Percentage of Science Process Skills Aspects Implemented Based on Observational Data During Instruction

The percentage results of the science process skills (SPS) observations provide a clear depiction of the differences in SPS between the control and experimental classes. Students who received guided inquiry treatment consistently achieved mastery levels above 80% across all SPS indicators. In contrast, students in the control class demonstrated mastery levels ranging from 65% to 77%, with an average difference of approximately 12–15% for each indicator. These differences are consistent with the results of the Mann–Whitney test, which indicated a statistically significant difference between the two classes (Sugiyono, 2013).

These findings can be explained through science process theory, which posits that science process skills develop optimally through authentic and structured inquiry experiences (Fathya Chaerunisa et al., 2023). Ratna Wilis Dahar (1985) emphasized that SPS are essential intellectual skills that must be cultivated through appropriate science education methods and approaches, in which teacher questioning and structured

guidance play a crucial role in directing students toward scientific thinking. Ongowo & Indoshi (2013) further argued that science process skills foster students' sense of responsibility in learning and enhance their appreciation of the importance of research methods in the learning process (Ongowo & Indoshi, 2013). Science process skills aim to encourage students to actively understand and master scientific procedures, including observing, classifying, interpreting, predicting, hypothesizing, planning experiments or investigations, and communicating scientific findings (Amita & Prasasti, 2017).

Several factors influenced the development of students' science process skills in this study: (1) the guided inquiry learning model provided a more structured and authentic investigative framework compared to conventional approaches; (2) students in the experimental class received gradual learning experiences prior to conducting observations; (3) the use of Wordwall-based post-test assessment supported students in reflecting on their understanding, thereby strengthening their science process skills; and (4) field observations of the school environment served as authentic learning experiences for the application of SPS (Mulyati et al., 2023). The success of the experimental class resulted from the optimal combination of these factors, which created a more effective learning environment. This finding supports the notion that students' science process skills develop through direct and meaningful experiences rather than through rote memorization alone (Iqbal Putra et al., 2022).

Based on the discussion above, it can be concluded that the guided inquiry model combined with Wordwall-based assessment has a significant effect on students' science process skills. Furthermore, this instructional approach contributes to the enhancement of students' science process skills..

The Relationship between Learning Outcomes and Science Process Skills

This study demonstrates that there is a relationship between students' learning outcomes and their science process skills (SPS). The relationship between learning outcomes and SPS was examined using Spearman's rank correlation test. The selection of Spearman's correlation was based on the results of the data normality test in the experimental class, which indicated that the data were not normally distributed; therefore, a non-parametric statistical test was applied. The analysis was conducted using post-test scores of learning outcomes and SPS questionnaire scores from the experimental class.

The results of the Spearman correlation test conducted using SPSS revealed a correlation coefficient of $\rho = 0.635$ with a significance value of $p = 0.000$ ($N = 35$). This correlation coefficient falls into the strong category, indicating that higher science process skills are associated with higher post-test learning outcome scores. The p-value ($p = 0.000$), which is far below $\alpha = 0.01$, indicates that this relationship is statistically highly significant (Sugiyono, 2013) The coefficient of determination ($\rho^2 = 0.403$ or 40.32%) indicates that science process skills contribute 40.32% to the variance in students' learning outcomes, while the remaining 59.68% is influenced by other factors. This strong relationship confirms that SPS is not merely a complementary component, but a crucial factor in students' mastery of biodiversity concepts (Ariyansyah & Nurfathurramah, 2022).

These findings are consistent with the science process skills theory proposed by Dahar (2011), which emphasizes SPS as a foundation of science learning because it facilitates authentic knowledge construction through inquiry and observational experiences. Science learning is not limited to concept development alone, but also requires scientific thinking and action skills to solve authentic problems (Aliyya Putri et al., 2025). In biodiversity learning, cognitive learning outcomes and science process skills are closely interrelated, as the content is contextual and field-observation-based. Activities such as classifying flora and fauna, as part of science process skills, help students organize biological data and construct taxonomic understanding (Rustaman, 2005). Measuring the distribution of living organisms in the field represents another aspect of science process skills that supports the development of ecosystem concepts (Syazali & Ilhamdi, 2022).

Furthermore, drawing conclusions from observational data strengthens students' understanding of biodiversity interactions within ecosystems (Rahmayanti et al., 2025).

A specific factor contributing to this strong relationship is the implementation of the guided inquiry learning model. The results showed that the level of learning implementation using the guided inquiry model reached 95.83%, indicating that the guided inquiry-based instruction was carried out effectively. The nature of guided inquiry in biodiversity learning requires students to engage in observation, identification, and analysis as prerequisites for conceptual understanding (Pertiwi et al., 2017). In addition, the structured syntax of guided inquiry systematically guides students through inquiry processes, thereby accelerating the development of both science process skills and cognitive learning outcomes (Khairatunnisa et al., 2024).

Another supporting factor contributing to this relationship is the assessment strategy. Wordwall-based assessment makes the relationship between science process skills and learning outcomes more evident because SPS are trained and measured throughout the assessment process (Lubis & Nuriadin, 2022). Previous studies have also shown that assessments focusing solely on memorization without measuring science process skills tend to weaken the relationship between learning outcomes and science process skills (Amnie & Ertikanto, 2014)

The strong relationship between science process skills and learning outcomes ($\rho = 0.635$; $\rho^2 = 0.403$) confirms that SPS are not merely supplementary, but constitute a key factor in achieving cognitive learning outcomes. Therefore, learning activities that place observation, identification, and analysis at the core of student engagement in biodiversity topics are proven to be effective in fostering deeper and more meaningful conceptual understanding (Latifah Nur et al., 2022).

The strong relationship between science process skills and learning outcomes ($\rho = 0.635$; $\rho^2 = 0.403$) confirms that SPS are not merely supplementary, but constitute a key factor in achieving cognitive learning outcomes. Therefore, learning activities that place observation, identification, and analysis at the core of student engagement in biodiversity topics are proven to be effective in fostering deeper and more meaningful conceptual understanding. During the implementation of the study, several constraints were encountered. In the assessment process using Wordwall, the school's Wi-Fi signal was weak and the internet connection was unstable. As a result, students experienced difficulties accessing the platform, which disrupted the smooth implementation of the assessment. Some students reported that the web page refreshed unexpectedly, causing previously completed responses to be lost and requiring them to repeat the assessment. To address these issues, the researcher provided additional time and advised students to use devices with more stable internet connections to ensure that the assessment process could proceed more effectively

CONCLUSION

Based on the results of the study, it can be concluded that: (1) the Guided Inquiry learning model and Wordwall-based assessment have a significant effect on students' learning outcomes, indicating that the integration of this model and assessment tool is effective in improving students' learning outcomes; (2) the Guided Inquiry learning model and Wordwall-based assessment have a significant effect on and contribute to the improvement of students' science process skills; and (3) there is a strong positive relationship between students' learning outcomes and their science process skills, where higher science process skills are associated with higher learning outcome scores.

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