Jurnal Ilmiah Pendidikan Citra Bakti

p-ISSN 2355-5106 || e-ISSN 2620-6641

https://jurnal.citrabakti.ac.id/index.php/jil

THE EFFECT OF AN INTERACTIVE MAP-ASSISTED DISCOVERY LEARNING MODEL ON INTEREST AND LEARNING OUTCOMES OF ELEMENTARY SCHOOL STUDENTS

Hayya Fathimah Az Zahra[1)*], Tri Astuti[2)]

[1,2)] Pendidikan Guru Sekolah Dasar, Universitas Negeri Semarang
*Corresponding author email: hayyafathimah@students.unnes.ac.id

Article History

Received:
January 21, 2026

Accepted:
April 30, 2026

Published:
May 18, 2026

Abstract

This study aims to: (1) analyze the effect of the discovery learning model supported by interactive maps on students' interest in learning Natural and Social Sciences (NSS); (2) analyze the effect of the discovery learning model supported by interactive maps on learning outcomes in NSS; and (3) analyze the simultaneous effect of the discovery learning model supported by interactive maps on students' interest and learning outcomes in IPAS. This study employed a quasi-experimental design of the nonequivalent control group type involving 56 fourth-grade students at SDN Ngadirgo 03, comprising an experimental class and a control class. Data were collected through observation, interviews, a learning interest questionnaire, and a learning achievement test. The learning interest questionnaire consisted of 16 valid and reliable Likert-scale statements (Cronbach's Alpha = 0.883). The learning achievement test consisted of 20 valid and reliable multiple-choice questions (Cronbach's Alpha = 0.895). The results indicate that: (1) the discovery learning model supported by interactive maps has a significant effect on increasing students' interest in learning IPAS (sig. 0.000 < 0.05), with an N-Gain of 0.64 (moderate category) in the experimental class, higher than the control class's 0.12 (low category); (2) the discovery learning model supported by interactive maps has a significant effect on improving NSS learning outcomes (sig. 0.000 < 0.05), with an N-Gain of 0.71 (high category) compared to 0.39 (moderate category) in the control class; and (3) based on the MANCOVA test, the model exhibited a significant simultaneous effect on interest and learning outcomes after controlling for pretest scores (sig. 0.000 < 0.05).

Keywords: discovery learning, interactive map, learning outcomes, interest in learning.

Abstrak. Penelitian ini bertujuan untuk: (1) menganalisis pengaruh model *discovery learning* berbantuan peta interaktif terhadap minat belajar IPAS; (2) menganalisis pengaruh model *discovery learning* berbantuan peta interaktif terhadap hasil belajar IPAS; dan (3) menganalisis pengaruh model *discovery learning* berbantuan peta interaktif terhadap minat dan hasil belajar IPAS secara simultan. Penelitian ini menggunakan desain quasi-eksperimen tipe *nonequivalent control group design* dengan 56 siswa kelas IV SDN Ngadirgo 03, terdiri atas kelas eksperimen dan kelas kontrol. Data dikumpulkan melalui observasi, wawancara, angket minat belajar, dan tes hasil belajar. Angket minat belajar terdiri atas 16 pernyataan skala Likert 1–4 yang valid dan reliabel (*Cronbach's Alpha* = 0,883). Tes hasil belajar terdiri atas 20 soal pilihan ganda yang valid dan reliabel (*Cronbach's Alpha* = 0,895). Hasil penelitian menunjukkan bahwa: (1) penggunaan peta interaktif dalam model *discovery learning* berpengaruh signifikan terhadap peningkatan minat belajar IPAS siswa (sig. 0,000 < 0,05), dengan N-Gain kelas eksperimen 0,64 (kategori sedang) lebih tinggi dibandingkan kelas kontrol 0,12 (kategori rendah); (2) penggunaan peta interaktif dalam model *discovery learning* berpengaruh signifikan terhadap peningkatan hasil belajar IPAS (sig. 0,000 < 0,05), dengan N-Gain kelas eksperimen 0,71 (kategori tinggi) dibandingkan kelas kontrol 0,39 (kategori sedang); dan (3) hasil uji MANCOVA menunjukkan pengaruh signifikan secara simultan terhadap minat dan hasil belajar IPAS setelah dikontrol skor awal (sig. 0,000 < 0,05).

Kata Kunci: *discovery learning*, peta interaktif, hasil belajar, minat belajar.

Background

Education is a fundamental foundation for developing high-quality human resources capable of contributing optimally to society (Suharti & Haifaturrahmah, 2025). In achieving this goal, the instructional process plays a crucial role as the primary space for developing students' knowledge and understanding. According to Gusmaneli et al. (2024), the quality of instruction is determined not only by how well the material is delivered but also by the extent to which it creates meaningful learning experiences for students. This is also emphasized in Permendikdasmen Article 9 Number 1 of 2026, which states that instructional activities should be designed to be interactive, inspiring, enjoyable, and challenging, while encouraging students to actively participate in the learning process. This principle is applied across subjects, including Natural and Social Sciences (NSS).

NSS is an integration of science and social studies that encourages students to observe phenomena, analyze cause and effect relationships, and understand the contextual connections between natural and social aspects (Himawan et al., 2025). These characteristics require an instructional approach that can stimulate students' enthusiasm and active participation. One important factor supporting this process is interest in learning. Interest in learning refers to an internal drive that encourages students feelings of happiness, engagement, interest, and attention in learning, thereby motivating them to participate without feeling burdened (Mendrofa et al., 2025). Tasdelen and Bodemer (2025) state that strong learning interest encourages students to participate actively, which contributes positively to student achievement. Learning outcomes reflect changes in students' abilities after the instructional process, including cognitive, affective, and psychomotor aspects, as indicators of students' mastery of the material (Ridha et al., 2025). Previous studies have shown that higher learning interest is associated with better learning outcomes. For example, Fatimah et al.

(2022) found that students with high learning interest achieved excellent results, with a percentage of 88.8%.

However, conditions in the field indicate that these expectations have not been fully achieved. Based on observations and interviews with fourth-grade teachers at SDN Ngadirgo 03, students' interest in learning and learning outcomes are still relatively low. This condition is influenced by several factors, including the complexity of NSS material, the use of less innovative instructional models, limited utilization of technology-based learning media, and an emphasis on memorization rather than conceptual understanding. In the topic of biodiversity, only 9 out of 56 students (16%) achieved the Criteria for Achieving Learning Objectives of 70, while 47 students (84%) did not meet the expected standard. This indicates that students' learning outcomes are still not optimal. This situation is closely related to teacher-centered instruction, which tends to limit students' active participation in the learning process (Bhardwaj et al., 2025). As a result, students have fewer opportunities to explore concepts independently and develop a deep understanding, leading to lower interest and less optimal learning outcomes. Therefore, an innovative instructional model is needed to support deeper and more meaningful student learning.

One instructional model considered suitable for addressing this issue is discovery learning. This model positions students as active participants in discovering concepts through systematic stages, including stimulation, problem identification, data collection, data processing, verification, and generalization (Kusumayuni et al., 2023). Through these stages, students are encouraged to explore information, process data, and draw conclusions independently, leading to deeper conceptual understanding and more meaningful learning experiences. This is in line with Bruner’s discovery learning theory (1961, as cited in Mandar, 2025), which suggests that knowledge becomes more meaningful when students discover it themselves through direct experience.

The implementation of discovery learning in NSS also requires appropriate learning media to enhance its effectiveness. In biodiversity topics, particularly the distribution of flora and fauna, students need to understand spatial information across different regions. Therefore, media that can present information visually and interactively is needed (Fitri et al., 2024). One relevant medium is a digital-based interactive map, which allows users to interact with information through features such as clicking, zooming, and navigation (Husna & Dora, 2025; Sahara et al., 2024). This type of media enables dynamic, visual, and contextual presentation of information, allowing students to explore learning materials actively according to their needs (Eraku et al., 2025). Through interactive maps, students can observe the distribution of flora and fauna, compare characteristics, and connect concepts with regional conditions

independently. This aligns with the principles of discovery learning, which emphasize active student involvement in constructing knowledge.

Several studies indicate that implementing the discovery learning model alongside interactive maps can enhance both student interest and learning outcomes. Indah et al. (2024) demonstrate that the application of discovery learning in elementary NSS instruction contributes significantly to these areas. Furthermore, Marella et al. (2023) found that interactive maps specifically improve academic achievement. However, research that integrates discovery learning with interactive maps in elementary NSS particularly to analyze their simultaneous effects on both interest and outcomes remains notably limited.

Based on this background, this study aims to: (1) analyze the effect of the discovery learning model supported by interactive maps on students' interest in learning NSS; (2) analyze its effect on learning outcomes in NSS; and (3) analyze the simultaneous effect of the model on students' interest and learning outcomes in NSS.

Method

This study employed a quantitative method utilizing a quasi-experimental design through the application of a nonequivalent control group design. The quasi-experimental approach is a research framework that compares the effects of a treatment on two groups without random assignment of subjects (Sugiyono, 2022). The study was conducted at SDN Ngadirgo 03 in Semarang City on fourth-grade students. The sampling technique used was total sampling (Arikunto, 2022), which involved all 56 fourth-grade students as research samples. Class IVA was designated as the experimental class that engaged in learning through the discovery learning model assisted by interactive maps, while class IVB acted as the control class that followed traditional learning methods. This study was conducted over two sessions per class, with each session lasting 70 minutes (2 × 35 minutes).

In this study, data was gathered via observation, interviews, distribution of questionnaires on learning interest, and administering tests to assess learning outcomes. The learning interest questionnaire consists of 16 statements rated on a 1–4 Likert scale. Validity testing confirmed that all statements are valid, and the Cronbach's Alpha reliability coefficient was 0.883, indicating a high level of reliability. The instrument's item list is presented in Table 1.

Table 1. Learning Interest Questionnaire Instrument Grid

Indicator	Statement Number
Feeling of Happiness	1, 2, 3, 4
Engagement in Learning	5, 6, 7, 8
Interest in Learning	9, 10, 11, 12
Attention in Learning	13, 14, 15, 16

Source: Slameto (2021)

The learning outcome test instrument consisted of 50 multiple-choice questions, from which 20 valid items were selected to represent all indicators and cognitive aspects being measured. A Cronbach's Alpha coefficient of 0.895 was obtained, indicating a high level of reliability. The instrument grid is presented in Table 2.

Table 2. Learning Outcome Test Instrument Grid

Learning Outcomes	Learning Objectives	Cognitive Aspects	Question Number
Students are able to describe biodiversity, cultural diversity, local wisdom, and conservation efforts.	Determining the distribution of flora and fauna	C2	1,2,3,5,6,8,9,11,16,18
	Categorize flora and fauna based on region	C3	7,12,15
	Analyze the distribution of flora and fauna based on their characteristics	C4	4,10,17,19,20

Source: Bloom, in Silaban et al. (2025)

The quantitative data was processed using statistical analysis facilitated by SPSS 26 included: (1) a normality test using the Shapiro-Wilk test; (2) a test of homogeneity of variances; (3) an independent samples t-test to evaluate the effect of the treatment on each dependent variable; (4) N-Gain analysis to measure changes in interest and learning outcomes; and (5) a MANCOVA test to determine the simultaneous effects on dependent variables.

Result and Discussion

The Effect of Interactive Map-Assisted Discovery Learning Models on Student Interest in Learning

Learning interest was measured using questionnaires provided to students before and after the treatment (pretest and posttest). Table 3 displays a summary of data regarding student learning interests

Table 3. Descriptive Statistics of Student

Kelas		Minimum	Maximum	Mean	Std. Deviation
Experiment	Pretest	37	43	40.11	1.641
	Posttest	50	59	55.35	2.281
Control	Pretest	37	47	40.82	2.358
	Posttest	40	49	43.64	1.948

Table 3 illustrates that the experimental group’s mean interest score increased from 40.11 to 55.35, whereas the control group showed a lesser rise from 40.82 to 43.64. Descriptively, the increase in learning interest in the experimental class was greater than that in the control class, as further reflected in Table 4.

Table 4. Percentage of Achievement per Learning Interest Indicator

Indicator	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Feeling of Happiness	61%	93%	58%	65%
Engagement in Learning	67%	82%	70%	72%
Interest in Learning	61%	85%	60%	64%
Attention in Learning	62%	85%	67%	73%

Based on Table 4, all learning interest indicators in both classes increased from the pretest to the posttest. In the experimental class, the indicator of feeling of happiness rose from 61% to 93%, engagement in learning from 67% to 82%, interest in learning from 61% to 85%, and attention in learning from 62% to 85%. Meanwhile, the increase in the control class was relatively lower, with the feeling of happiness indicator increasing from 58% to 65%, engagement in learning from 70% to 72%, interest in learning from 60% to 64%, and attention in learning from 67% to 73%.

The following step involves performing a normality test as part of the prerequisite testing. Table 5 displays a summary of the results from the normality test.

Table 5. Normality Test of Learning Interest

Class		Shapiro-Wilk		
		Statistic	Df	Sig.
Experiment	Pretest	0.942	28	0.128
	Posttest	0.952	28	0.052
Control	Pretest	0.936	28	0.120
	Posttest	0.944	28	0.144

Based on Table 5, the Shapiro-Wilk test was employed for normality testing, as the sample size was below 50 (Sugiyono, 2023). The analysis results show that all groups and variables (pretest and posttest) had a Sig. value greater than 0.05, indicating that the data are normally distributed (Machali, 2021).

Once the data was confirmed to be normally distributed, homogeneity testing was performed, and the results are presented in Table 6.

Table 6. Homogeneity Test of Learning Interest

Class	Levene Statistic	Sig.
Pretest	2.585	0.133
Posttest	2.557	0.209

Table 6 displays the homogeneity test results using Levene's Test, with Sig. values > 0.05 for both pretest and posttest, indicating that the variance of both groups is homogeneous (Widodo, et al., 2023).

After prerequisite assumptions were met, an independent samples t-test was conducted to determine the significance of differences in learning interest between the two classes. Table 7 displays the summary of the test results.

Table 7. Independent T-test of Learning Interest

	T	Df	Sig. (2-tailed)	Mean Difference
Interest in Learning	20.668	54	0.000	11.714

Based on Table 7, the findings from the independent t-test show a Sig. (2-tailed) value of 0.000 < 0.05, meaning H_0 is rejected and H_1 is accepted, indicating a significant difference in learning interest between the experimental and control classes (Fitri, et al., 2023).

After the t-test, an N-Gain test was conducted to measure the improvement in student learning interest. The outcomes of the N-Gain test for learning interest are shown in Table 8.

Table 8. N-Gain Test of Interest in Learning

Kelas	Minimum	Maximum	Mean N-Gain
Experiment	45.45	80.77	0.64
Control	-5.26	25.00	0.12

Based on Table 8, the experimental group achieved an average N-Gain for learning interest of 0.64 (moderate category), while the control group only attained 0.12 (low category), based on the criteria set by Hake (1998, as cited in Agustianti et al., 2022). These results indicate that the increase in learning interest was higher in the experimental class than in the control class.

The Effect of Interactive Map-Assisted Discovery Learning Models on Student Learning Outcomes

To determine student learning outcomes, tests were administered before and after the treatment (pre-test and post-test). Table 9 provides a comprehensive summary of the data collected from the assessment of learning results.

Table 9. Statistical Descriptions of Student Learning Outcomes

Class		Minimum	Maximum	Mean	Std. Deviation
Experiment	Pre-test	30	70	55.00	10.453
	Post-test	65	100	86.79	8.842
Control	Pre-test	35	80	58.04	11.084
	Post-test	50	95	73.75	11.436

According to Table 9, the average learning outcomes for the experimental class increased from 55.00 to 86.79, while the control class showed a smaller increase, from 58.04 to 73.75. Descriptively, the improvement in learning outcomes in the experimental class was greater than that in the control class, as also reflected in the achievement percentages for each indicator in Table 10.

Table 10. Percentage of Achievement per Learning Outcome Indicator

Indicator	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Determining (C2)	63%	94%	66%	78%
Grouping (C3)	52%	84%	54%	74%
Analyzing (C4)	44%	79%	47%	69%

Based on Table 10, all three learning outcome indicators in the experimental class showed an increase compared to the control class. For example, the determining indicator (C2) in the experimental class increased from 63% to 94%, compared to the control class, which increased from 66% to 78%. The grouping indicator (C3) increased from 52% to 84% in the experimental class and from 54% to 74% in the control class. Similarly, the analyzing indicator (C4) increased from 44% to 79% in the experimental class, while in the control class it increased from 47% to 69%.

The next step is to perform a normality test as a prerequisite to ensure that the data is normally distributed. Table 11 shows a summary of the results from the normality test.

Table 11. Normality Test of Learning Outcomes

Class		Shapiro-Wilk		
		Statistic	Df	Sig.
Experiment	Pre-test	0.947	28	0.164
	Post-test	0.930	28	0.061
Control	Pre-test	0.961	28	0.365
	Post-test	0.956	28	0.277

According to Table 11, the findings indicate that every group and variable (pretest and posttest) received a Sig. value > 0.05, demonstrating that the data follow a normal distribution.

Once the data was confirmed to be normally distributed, homogeneity testing was performed, and the results are presented in Table 12.

Table 12. Homogeneity Test of Learning Outcomes

Class	Levene Statistic	Sig.
Pre-test	0.022	0.883
Post-test	0.943	0.336

Table 12 displays the homogeneity test results using Levene's Test, with Sig. values > 0.05 for both pretest and posttest, indicating that the variance of both groups is homogeneous.

After prerequisite assumptions were met, an independent samples t-test was conducted to determine the significance of differences in learning interest between the two classes. A summary of the test results is presented in Table 13.

Table 13. Independent T-test of Learning Outcomes

	T	Df	Sig. (2-tailed)	Mean Difference
Learning Outcomes	4.772	54	0.000	13.036

Based on Table 13, the findings from the independent t-test show a Sig. (2-tailed) value of 0.000 < 0.05, meaning H_0 is rejected and H_1 is accepted, indicating a significant difference in learning outcomes between the experimental and control classes.

After the t-test, an N-Gain test was conducted to measure the improvement in student learning outcomes. Table 14 presents the results of the analysis.

Table 14. N-Gain Test of Learning Outcomes

Kelas	Minimum	Maximum	Mean N-Gain
Experiment	42.86	100.00	0.71
Control	9.09	75.00	0.39

Based on Table 14, the experimental class achieved a mean N-Gain for learning outcomes of 0.71 (high category), while the control class only attained 0.39 (moderate category). These results indicate that the improvement in learning outcomes was higher in the experimental class than in the control class.

The Effect of Interactive Map-Assisted Discovery Learning Model on Students' Interest and Learning Outcomes

A MANCOVA test was conducted to analyze the simultaneous effect of the interactive map-assisted discovery learning model on students' learning interest and learning outcomes, while controlling for pretest scores, with results presented in Table 15.

Table 15. MANCOVA Test of Interest and Learning Outcomes

Effect	Statistics	Value	F	Sig.
Intercept	Wilks' Lambda	0.502	25.339	0.000
Pretest Interest		0.870	3.810	0.029
Pretest Results		0.749	8.542	0.001
Group		0.091	256.135	0.000

Based on Table 15, the group variable showed a Wilks' Lambda value of 0.091 with a significance level of 0.000 < 0.05, meaning H_0 is rejected and H_1 is accepted, indicating a significant simultaneous effect on both dependent variables (Tabachnick & Fidell, 2019). Additionally, the covariates of pretest learning interest (Sig. = 0.029) and pretest learning outcomes (Sig. = 0.001) also showed significant effects, indicating that both variables contribute to the variation in students' learning interest and learning outcomes.

Discussion

Based on the research findings, the implementation of the discovery learning model combined with interactive maps contributes to increasing students' interest in learning science in elementary school. In the control class, teacher-centered instruction limited student participation, resulting in less optimal development of learning interest. In contrast, in the experimental class, students demonstrated higher levels of enthusiasm, focus, and participation as they were given the opportunity to explore and construct understanding independently through interactive maps, making the learning process more meaningful. This finding is in line with Ansya and Salsabilla (2025), who state that the use of interactive media in the discovery learning model can create engaging and meaningful learning experiences and support the improvement of students' learning interest.

In terms of feeling of happiness, the discovery learning model aided by interactive maps ensures that students are not merely passive recipients of information but are actively involved in exploring and discovering concepts independently. Interactive maps help students visualize the material in a concrete and enjoyable way, making learning more dynamic and meaningful. This fosters a sense of enjoyment, as students perceive learning as an engaging experience rather than a burden. This positive emotional experience also encourages students to participate more actively in the learning process. This is in line with Ta'rifudin and Mastoah (2025), who state that a learning environment that provides space for exploration can enhance students' learning interest.

In terms of engagement, the discovery learning model positions students as active participants in the learning process, from seeking and processing information to discussing and drawing conclusions collaboratively. This involvement makes learning more meaningful, as students feel that their contributions influence the outcomes. Students also develop interaction, critical thinking, and communication skills, making the learning process more dynamic. Such active participation strengthens students' sense of responsibility toward their own learning. This aligns with Astuti et al. (2024), who explain that active engagement is a key factor in improving learning motivation and outcomes.

In terms of interest, the discovery learning model supported by interactive maps encourages students to actively observe and explore the material. Interactive maps present information visually and spatially, helping to make abstract concepts more concrete and easier to understand. The interactive features also motivate students to explore further and draw conclusions independently. This condition encourages students to become more curious and willing to engage with the material. As a result, students' interest increases as learning becomes both enjoyable and challenging. This is consistent with Ali et al. (2025), who state that interactive learning media can stimulate students' interest and make learning more meaningful.

In terms of attention, the discovery learning model using interactive maps helps students maintain focus throughout the learning process. The dynamic presentation of maps stimulates curiosity, encouraging students to observe and analyze the material continuously. Students also learn to connect information and understand relationships between concepts, making learning more active and engaging. This continuous stimulation helps prevent students from losing focus during the lesson. This is supported by Sawitri et al. (2024), who state that interactive media can sustain students' attention for longer periods.

Overall, all four indicators of learning interest including feeling of happiness, engagement, interest, and attention in learning showed an increase in the experimental class. These findings indicate that the implementation of the discovery learning model supported by interactive maps contributes to the creation of a more meaningful and student-centered learning process.

The results of the study indicate that the implementation of a discovery learning model supported by interactive maps contributes to improved student learning outcomes in science education at the elementary school level. In the control class, the teacher-centered learning approach tended to make students passive, resulting in suboptimal understanding and consequently suboptimal learning outcomes. Conversely, in the experimental class, students were actively engaged in the process of exploration, discussion, and concept discovery through interactive maps, leading to a deeper understanding of the material. This situation

resulted in improved learning outcomes for the students. These findings align with Fanani and Fardani (2025), who state that students' active involvement in the discovery learning model supported by interactive media can deepen understanding, thereby leading to improved learning outcomes.

In the determining indicator (C2), the discovery learning model supported by interactive maps helps students identify and define concepts more accurately. The visualizations presented on interactive maps make abstract concepts more concrete and easier to observe. This enables students to recognize, distinguish, and define concepts based on direct observation. This process not only allows students to know a concept but also to understand it more deeply, making learning more meaningful. This is in line with Bara et al. (2024), who state that learning that encourages students to construct their own understanding results in better comprehension.

In the grouping indicator (C3), the discovery learning model encourages students to actively seek, sort, and categorize information. This ability requires students to understand similarities and differences, and therefore cannot develop optimally if learning is passive. Through exploration activities, students are trained to organize information based on specific characteristics, making their understanding of relationships between concepts more structured. As a result, students not only know the grouping outcomes but also understand the reasoning behind them. This is consistent with Nurjihan and Bunawan (2025), who state that active exploration can strengthen students' understanding.

In the analyzing indicator (C4), the discovery learning model supported by interactive maps provides opportunities for students to develop higher-order thinking skills. Students are not only involved in observing information but also in processing, discussing, and drawing conclusions independently. Interactive maps help students connect various pieces of information and understand the relationships between concepts more clearly. This process trains students to think critically and systematically in understanding the material. This aligns with Busdayu et al. (2023), who state that higher-order thinking skills develop through active and continuous learning processes.

Overall, the three learning outcome indicators measured including determining (C2), grouping (C3), and analyzing (C4) showed greater improvement in the experimental class. This suggests that the discovery learning model supported by interactive maps enhances student learning outcomes through active engagement, enabling students not only to acquire information but also to construct understanding, making learning more meaningful.

Based on the results of simultaneous statistical tests, the discovery learning model supported by interactive maps has a positive effect on students' interest and learning outcomes in science education at the elementary school level. This is evident in the experimental class,

which demonstrated higher levels of interest and better learning outcomes compared to the control class. In the control class, the teacher-centered approach limited student engagement, resulting in less optimal development of learning interest and affecting learning outcomes. In contrast, in the experimental class, students' active engagement in exploring and discovering concepts through interactive maps fostered higher learning interest and contributed to improved learning outcomes. This indicates that learning interest and learning outcomes are closely related, where higher interest encourages active engagement and leads to deeper understanding.

The implementation of the discovery learning model emphasizes students' active engagement through problem exploration, information gathering and processing, and independent conclusion-drawing. This process helps students develop deeper conceptual understanding as well as critical and systematic thinking skills. Rahmah et al. (2023) state that active engagement in the discovery process can improve the quality of understanding and impact learning outcomes. In addition, students' direct involvement in learning supports the development of learning interest indicators, including feeling of happiness, engagement, interest, and attention. Increased learning interest encourages students to participate more actively, allowing their understanding to develop from determining (C2), grouping (C3), to analyzing (C4). This is consistent with Sandi et al. (2024), who state that high learning interest can promote active participation and improve learning outcomes.

The use of interactive maps as a learning medium strengthens the relationship between students' interest and learning outcomes. Interactive maps encourage students to explore information independently and engage in collaborative discussions, which deepen their conceptual understanding. Prameisila et al. (2025) emphasize that interactive media can facilitate more active exploration in learning. In addition, interactive maps function not only as visual aids but also as stimuli that sustain students' interest and attention throughout the learning process. This sustained engagement occurs without reliance on external prompts. This is in line with Jaya et al. (2024), who state that visual and interactive media can create a more engaging and enjoyable learning environment.

Overall, integrating the discovery learning model with interactive maps not only increases students' interest in learning but also strengthens the link between interest and learning outcomes through students' active engagement in the learning process. Learning that involves exploration, interaction, and independent discovery of concepts makes the learning experience more meaningful, thereby supporting the simultaneous improvement of both aspects.

Conclusion

The results of the analysis indicate that: (1) the discovery learning model supported by interactive maps has a significant effect on increasing students' interest in learning NSS (sig. 0.000 < 0.05), with the experimental class showing an N-Gain score of 0.64 (moderate category), which is higher than the control class score of 0.12 (low category); (2) the discovery learning model supported by interactive maps has a significant effect on increasing students' learning outcomes in NSS (sig. 0.000 < 0.05), with the experimental class showing an N-Gain score of 0.71 (high category) compared to 0.39 (moderate category) in the control class; and (3) the discovery learning model supported by interactive maps has a significant simultaneous effect on students' interest and learning outcomes after controlling for pretest scores based on the MANCOVA test results (sig. 0.000 < 0.05). Based on these findings, the discovery learning model supported by interactive maps has a significant effect on enhancing fourth-grade students' interest and learning outcomes in NSS.

Therefore, teachers are advised to consider optimizing the implementation of the discovery learning model supported by interactive maps, both for biodiversity-related material and other NSS topics, to enhance students' interest and learning outcomes. For future researchers, this study is expected to serve as a reference for further investigations on the application of this model across different educational levels and broader learning contexts.

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