Unnes.J.Biol.Educ. 13 (1) (2024)

Journal of Biology Education

http://journal.unnes.ac.id/sju/index.php/ujbe

Effectiveness of Guided Discovery Model Based on Blended Learning to Improve Learning Outcomes in Ecosystem Materials.

Cendikia Hesti Ariyani, Yustinus Ulung Anggraito[1]✉

[1]Biology Department, FMIPA, Universitas Negeri Semarang, Indonesia

Article Info

Article History:

Received : January 2023

Accepted : March 2023

Published : April 2024

Keywords:

Guided discovery, blended learning, learning interest, cognitive learning outcomes

Abstract

The blended learning strategy in biology education at SMA Negeri 11 Semarang faces challenges such as limited face-to-face time, teacher-centered methods, and limited student interaction, resulting in an uninteresting experience and low learning outcomes in Class X 2020 Final Semester Assessment (PAS) /2021 Ecosystem Topic. This study aims to analyze the effectiveness of the guided discovery model based on blended learning on students' learning interest and cognitive learning outcomes in the ecosystem topic at SMA N 11 Semarang. Using a quasi-experimental design with a non-equivalent control class, Class X MIPA 5 was the experimental class, and Class XI MIPA 6 served as the control class. The research instruments included pre-tests, post-tests, a learning interest questionnaire, and an observation sheet. The results that the experimental class showed high interest and had significant differences in cognitive learning outcomes compared to the control class. There is a positive correlation between interest and learning outcomes. The implementation of guided discovery based on blended learning on the topic of ecosystems is categorized as very high. It is concluded that the guided discovery model based on blended learning proved effective in developing students' interest and enhancing their cognitive learning outcomes in the ecosystem subject.

✉Correspondence Address:
D6 Building 1st Floor Jl Raya Sekaran Gunungpati Semarang
E-mail: anggraitoulung27@mail.unnes.ac.id

p-ISSN 2252-6579
e-ISSN 2540-833X

INTRODUCTION

Minister of Education, Culture, Research, and Technology Regulation Number 16 of (Peraturan Menteri Pendidikan Kebudayaan Riset dan Teknologi Republik Indonesia, 2022) regarding Education Process Standards in Article 2 states that process standards serve as a foundation for conducting effective and efficient learning to optimally develop the potential, creative and innovative thinking, self-ability, and independence of students. Learning planning is one component of the process standards and is crucial for achieving learning goals.

The implementation of online distance learning with blended learning strategies in SMA Negeri 11 Semarang, particularly in the subject of Biology, faces several challenges. In face-to-face learning, the time allocated for Biology lessons has been reduced to 2 class periods (CP), with each CP lasting only 30 minutes compared to the previous 45 minutes. This limited time allocation forces teachers to use lecture and question-and-answer methods to cover all the material within a short time. Interaction between teachers and students is also limited as students primarily focus on taking notes of the points conveyed by the teacher. Students are given independent tasks to study the unrevealed material. Interviews with 75 students from Class XI revealed their complaints about tasks that made them less interested in learning, leading to frequent late submissions. Additionally, students feel bored and lack focus during lessons, diverting their attention to social media platforms such as Twitter, TikTok, and Instagram. These findings align with UNESCO & IESALC (2020) and Yunitasari & Hanifah (2020) studies that indicate a decrease in students' learning interest due to less engaging learning experiences during the pandemic. Dahliani et al. (2020) also proved a correlation between learning interest and learning outcomes, where students with low learning interest tend to achieve low learning outcomes as well. This is supported by data from the Final Semester Assessment (PAS) for Class X in the 2020/2021 academic year, particularly in the topic of Ecosystems, which showed that only 59.3% of 252 students achieved learning mastery in the Ecosystems topic, while 40.7% of students did not reach learning mastery. Mulyasa (2014) explains that successful learning is indicated by more than 75% of students achieving the school's learning mastery criteria. Students have different levels of understanding the ecosystem topic, with top-performing students grasping the material faster, while lower-performing students require more time to comprehend it.

The implementation of blended learning strategies is a solution to address the challenges of current learning. However, an appropriate learning model is needed to enhance cognitive learning outcomes. Guided discovery learning is a process where teachers provide specific topic examples and guide students to understand the topic (Fives & Susnosky, 2017). Students who engage in guided discovery learning actively discover knowledge until the acquired results become ingrained in their memory (Hosnan, 2016). Guided discovery learning assists students in constructing the given material through explanations, feedback, clarification from teachers and other students, as well as class discussions in the classroom (Graham, 2019). The guided discovery learning model fosters students' learning interest (Prasetyo & Abduh, 2021) and improves students' understanding and learning outcomes (Ayodele & Nasiru, 2021).

Based on the aforementioned background, research is needed to analyze students' learning interest in the implementation of the guided discovery model based on blended learning in the ecosystem topic at SMA Negeri 11 Semarang, as well as to assess the effectiveness of this model in improving students' cognitive learning outcomes.

RESEARCH METHOD

This research employed a quasi-experimental design with a non-equivalent control class design. The study population consisted of 252 tenth-grade students from SMA Negeri 11 Semarang's Science Class (X MIPA). These students were distributed across 7 classes. Purposive sampling was utilized as the sampling technique, resulting in the selection of Class X MIPA 5 as the experimental class, exposed to the guided discovery model based on blended learning, and Class X MIPA 6 as the control class, receiving regular classroom instruction as per the school's standard practice. The research was conducted during the even semester of the 2021/2022 academic year. Face-to-face instruction was conducted in 4 sessions, with each session lasting 2 hours or 60 minutes. During the first session, a pre-test was administered, followed by a discussion of ecosystem components and interactions. The second session covered the topics of energy flow and ecological pyramids. The third session involved the discussion of biogeochemical cycles and ecosystem changes. In the final session, a post-test was conducted as part of the learning evaluation process in both classes. The steps of the guided discovery based on blended learning are outlined in Table 1.

Table 1 The steps of guided discovery based on blended learning

BL Components	Activities in Ecosystem Topic	Guided Discovery Syntax
E-learning	The teacher sends learning topics and content via Ms. Teams. Additionally, students are asked to search for supplementary learning sources on the internet for independent study.	
	The teacher shares Discussion Sheets through Ms. Teams. Students are tasked with working on problems within the Discussion Sheets in class, aiming to enhance cognitive skills in formulating hypotheses.	
Face to Face	The teacher provides stimuli in the form of videos/photo cards/illustrated articles and poses questions to stimulate student understanding.	Stimulation
	Students engage in further discussion within their classs to identify issues using Discussion Sheets.	Problem statement
	Students, along with their classs, gather relevant information about the issues on the Discussion Sheets by reading literature from books and the internet.	Data collection
	Activity of processing data by matching the existing theories.	Data Processing
	Students present their discussion findings, while other classs provide feedback, leading to inter-class discussions and comparisons of results.	Verification
	The teacher guides students in constructing discussion outcomes and drawing conclusions.	Generalization

The instrument used to determine students' learning interest is a closed questionnaire. The questionnaire comprises 30 statements utilizing the Rating Scale measurement type, including (1) strongly agree (SA), (2) agree (A), (3) disagree (D), and (4) strongly disagree (SD). The questionnaire consists of both positive and negative statements. This aims to prevent respondents from leaning towards answering "agree" without fully comprehending the questions, ensuring the resulting data is more accurate and objective. The learning interest questionnaire employs a guideline grid as presented in Table 2.

Table 2 Learning interest questionnaire guideline grid

No	Dimensions	Indicator	Question Items	
			Positive	Negative
1	Joyment	Enthusiasm	2, 3	20
		Initiative	1, 4	26
2	Interest	Responsive	9, 13, 16	25
		Readiness	11, 30	8
3	Attention	Concentration	5, 6	10
		Precision	7, 17, 29	15
4	Engagement	Willingness	12, 14	28
		Tenacity	18, 21, 24	23
		Hard Work	19, 22	27
Count			12	9

The percentage of students' learning interest is calculated using the Microsoft Excel application by dividing the obtained score by the maximum score, and then multiplying the result by one hundred percent. The minimum percentage of students' learning interest must meet the high criteria.

Table 3 Learning interest criteria

Interval (%)	Criteria
$81{,}25 < p \leq 100$	Very High
$62{,}25 < p \leq 81{,}25$	High
$43{,}75 < p \leq 62{,}25$	Low
$25 < p \leq 43{,}75$	Very Low

A test instrument is employed to measure cognitive learning outcomes through a set of 20 multiple-choice questions, both in the pre-test and post-test phases. The pre-test serves as a foundation to gauge the

extent of students' understanding of the ecosystem subject matter, while the post-test generates data to be processed in evaluating the achievement of cognitive learning outcomes related to the ecosystem topic. A correct answer is assigned a score of 1, while an incorrect or unanswered response receives a score of 0. The acquired data is analyzed through classical attainment level, N-gain analysis, and Hypothesis Testing utilizing the independent sample t-test. The calculation of classical attainment level is aided by Microsoft Excel, involving the determination of the number of students who score above the Minimum Competency Criteria (≥70) divided by the total number of students, multiplied by 100%. The application of guided discovery based on blended learning is deemed effective if it achieves a classical attainment level of ≥75%. The blended learning-based guided discovery model is considered effective when there is an increase in the learning outcomes score (N-gain) that a medium or high level of criteria. The calculation of N-gain is performed using the Microsoft Excel application with the following formula.

$$g = \frac{(S_{post-test}) - (S_{pre-test})}{S_{maks} - (S_{pre-test})}$$

Information:
g= gain score

Table 4 N-gain criteria

Interval (%)	Criteria
$g \geq 0,7$	High
$0,3 < g < 0,7$	Medium
$g \leq 0,3$	Low

Source: Hake (1999)

Independent sample t-test results can be accepted if it shows 2-tailed <0.05. These results indicate that there are significant differences in learning outcomes with guided discovery based on blended learning. The data on learning interest and cognitive learning outcomes were analyzed to determine the correlation between learning interest and learning outcomes using the Pearson correlation test in the IBM SPSS Statistics 27 application. If the Pearson correlation test score has a significance value < 0.05, then there is a relationship between learning interest and learning outcomes.

Table 5 Pearson's correlation coefficient interpretation criteria

Interval (%)	Criteria
$0,80 < r_{xy} \leq 1,00$	Very High
$0,60 < r_{xy} \leq 0,80$	High
$0,40 < r_{xy} \leq 0,60$	Medium
$0,20 < r_{xy} \leq 0,40$	Low
$0,00 < r_{xy} \leq 0,20$	Very Low

Source: Sugiyono (2015)

An Observation Sheet is employed to assess the implementation of the guided discovery based on blended learning as supplementary research data (secondary data). The observation sheet employs a Rating Scale measurement with three alternative response options, where alignment with the Lesson Plan (RPP) is scored as 3, partial alignment as 2, and lack of alignment as 1. The execution of the blended learning-based guided discovery model is evaluated through a percentage, with a high level of criteria being the minimum requirement. The analysis of implementation of the guided discovery based on blended learning dividing the obtained score by the maximum score, and then multiplying the result by one hundred percent.

Table 6 Implementation of the guided discovery based on blended learning criteria

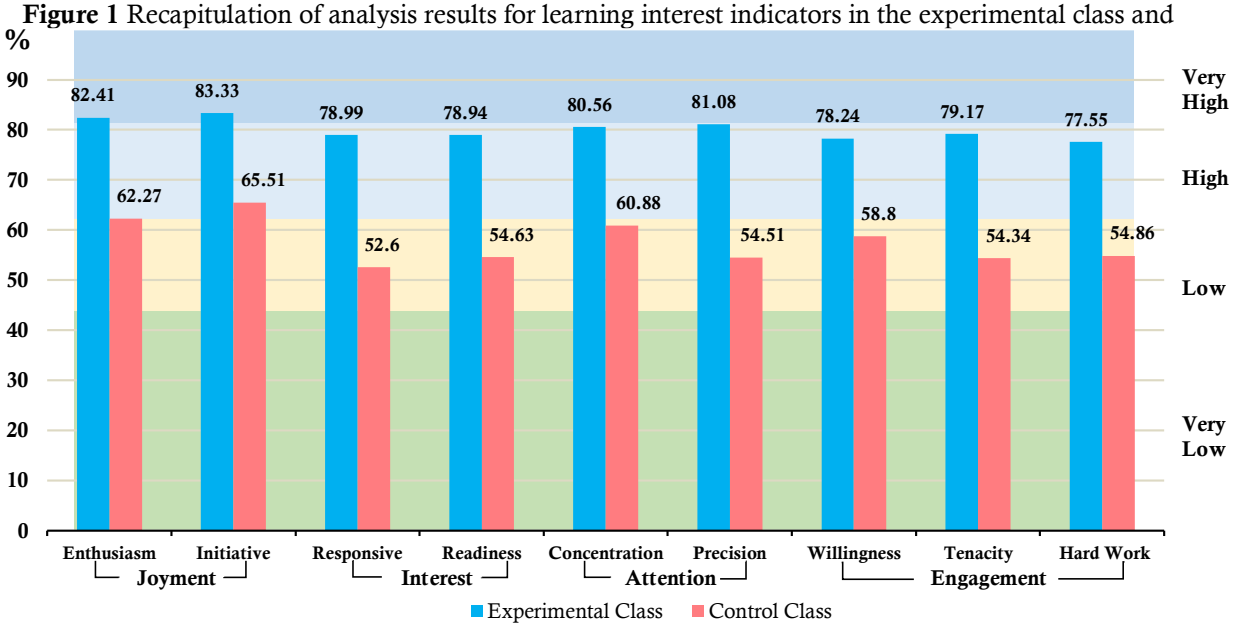
Interval (%)	Criteria
$81,25 < p \leq 100$	Very High
$62,25< p \leq 81,25$	High
$43,75 < p \leq 62,25$	Low
$25< p \leq 43,75$	Very Low

RESULTS AND DISCUSSION

Students' Learning Interest

The analysis of learning interest is based on four dimensions, which consist of several indicators including (1) Joyment consisting of enthusiasm and initiative; (2) Interest consisting of responsiveness and eagerness; (3) attention consisting of concentration and precision; (4) engagement, consisting of willingness, perseverance, and hard work. The results of the indicator achievement data in each dimension of interest in learning can be seen in Figure 1.

Figure 1 Recapitulation of analysis results for learning interest indicators in the experimental class and



control class

Based on Figure 1, it is evident that the experimental class performs better than the control class in terms of achieving higher percentages in each indicator within every dimension of learning interest. The dimension of joyment stands out with the highest percentages, with the experimental class achieving an impressive 82.87%, categorized as a very high level, while the control class lags slightly behind with 63.89%, still within the high criteria. Similarly, in the dimension of interest, the experimental class excels with a percentage of 78.96%, falling into the high criteria. Meanwhile, this dimension obtains the lowest percentage among the dimensions of learning interest in the control class, with a percentage of 53.62%, classified as low criteria. Furthermore, in the dimension of attention, the experimental class maintains a significant advantage with a percentage of 80.82%, meeting the high criteria, while the control class manages only 57.70%, classified as low criteria. Even though the involvement dimension records the lowest percentage in the experimental class at 78.32%, still meeting the high criteria, it surpasses the control class, which achieves only 56%. These findings indicate that each dimension of interest in learning in the experimental class exceeds 62.25%, with an average interest percentage of 80%, which means it has a high level of effectiveness. In contrast, the control class does not meet the effectiveness indicators as well, with only the dimension of joyment exceeding 61.25%, while the other dimensions are below 61.25%. Overall, the average interest percentage in the control class is 57.22%, indicating a low level of effectiveness. Therefore, the implementation of the guided discovery model based on blended learning has a positive impact on learning interest.

The use of e-learning components in blended learning enhances students' flexibility in accessing materials before face-to-face lessons, providing freedom and comfort in the learning process, which makes learning enjoyable (Vavasseur et al. (2020). Combining face-to-face interactions with a guided discovery model that focuses on students is also effective in increasing students' interest in learning by stimulating their curiosity through tailored stimulus syntax aligned with their learning styles (Buhl-Wiggers et al., 2023; Renninger & Hidi, 2020). For example, using videos for audiovisual learners, photocard for visual learners, and illustrated articles for verbal/linguistic learners. This fosters enthusiasm among students for the subject (Almasri, 2022; Gardner, 2015; Subagja & Rubini, 2023). Enthusiastic students are more motivated to take actions, such as solving problems on the Student Discussion Sheet (LDPD) at home and seeking information

from various internet sources. This aligns with the theories of Ainley (2017) and Pekrun & Perry (2014), emphasizing that situational interest is formed through learner-centered learning stimulation and encourages active student participation in learning.

Interest is indeed related to engagement. High interest among students in the experimental class regarding the ecosystem material encourages willingness students to develop new knowledge, connect concepts to everyday life, and exercise self-control in understanding knowledge (Shin et al., 2019; Sinatra et al., 2014). This triggers active engagement of students in asking questions, providing answers, and sharing opinions during face-to-face learning with guided discovery syntax, as well as interactions during learning (Arwaty & Lullulangi, 2022; Järvelä & Renninger, 2014). Previous research has demonstrated that discovery learning stimulates curiosity, which in turn impacts students' activity levels, motivates them to work hard in finding answers to problems, and builds self-efficacy towards tenacity in learning (Atiyah et al., 2020; Syafyahya & Yades, 2020; Widodo et al., 2019).

Students in guided discovery-based blended learning models show high levels of engagement by paying close attention and taking notes on information provided by both peers and teachers. Additionally, they demonstrate attentiveness by providing feedback during the verification syntax. Feudel & Fehlinger (2023) confirm that the face-to-face component increase attention through active participation in discussions and learning activities, while Khodaei et al. (2022) have found that the e-learning component allows students to manage their time optimally, improve concentration, and develop self-awareness in organizing cognitive processes through self-directed learning.

Students' Learning Outcomes

Based on the analysis of pre-test and post-test scores, it can be observed that there is an equal number of students who achieved the minimum passing grade (≥70) in both the experimental and control classes, which is 19 out of a total of 36 students. After analyzing the post-test scores, it is evident that the number of students who achieved the passing grade increased to 34 in the experimental class and 30 in the control class. The results of the data are presented in Figure 2.

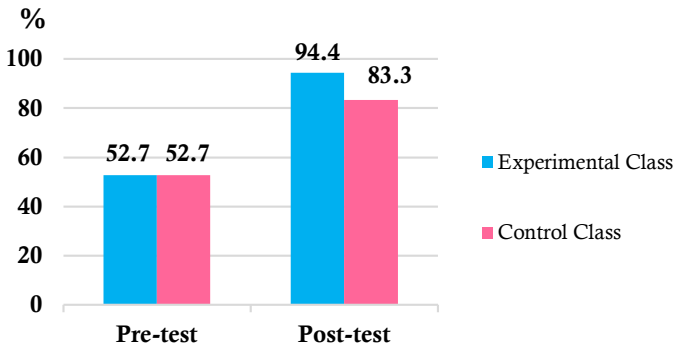


Figure 2 Classical attainment level in the experimental class and control class

Figure 2 indicates that the majority of students in both the experimental and control groups did not achieve the minimum passing score (≥70) on the pre-test. This could be attributed to their limited prior knowledge of the subject matter, as they may have had little prior experience in studying this particular field. However, after receiving the treatment, there was an increase in the percentage of students in the experimental group by 41.7% and in the control group by 30.6%. Nevertheless, the percentage of students who reached proficiency in the experimental group was higher than in the control group, with a difference of 11%. Therefore, it can be concluded that the implementation of the guided discovery model based on blended learning had a more positive impact on students' cognitive learning outcomes.

Based on the average pre-test and post-test scores, cognitive learning improvement can be determined through the N-gain test, which is presented in Table 7.

Table 7 N-gain score in the experimental class and control class

Class	Average Score		N-Gain	Criteria
	Pre-test	Post-test		
Experimental	67,50	81,58	0,46	Medium
Control	67,64	71,94	0,19	Low

According to Table 7, the difference in N-gain scores between the experimental and control classes is 0.27. Cognitive learning improvement in the control class is low (N-gain score < 0,3), while the experimental class achieved a moderate improvement (N-gain score: 0,3 < g < 0,7). These results indicate that the implementation of the guided discovery-based blended learning model is effective in enhancing cognitive learning outcomes.

Before hypothesis testing, the pretest and posttest data in the experimental and control classes have met the parametric assumptions following verification for normality and homogeneity. The results of the Independent Sample T-test can be observed in the Table 8.

Table 8 The results of independent sample t-test in the experimental class and control class

Experimental and Control Class Scores	Independent Sample T-Test Results		
	Number of students	Sig. (2-tailed)	Information
Pre-test	70	0,952	No difference
Post-test	70	0,000	There is a difference

Based on Table 8, it was found that the pre-test data had a significance score exceeding 0.05, while the post-test data had a significance score less than 0.05. These results indicate that before any intervention, there was no significant difference in cognitive learning outcomes between the two classes. However, after the intervention, a highly significant difference in cognitive learning outcomes was observed between the experimental and control classes. This suggests that the guided discovery-based blended learning model is effective in improving cognitive learning outcomes in the topic of ecosystems.

The relationship between the interest factor and cognitive learning outcomes is examined through Pearson correlation tests presented in the Table 9.

Table 9 The results of the correlation test between interest and learning outcomes

Variable	Pearson Correlation		Sig. (2-tailed)	
	Coefficient	Criteria	Scor	Information
Correlation between interest and learning outcomes	0,596	Medium	0,00	There is a correlation

Based on the Table 9, it is known that the correlation between interest and learning outcomes shows a significance score of less than 0.05 with a moderate criterion. This result indicates a positive and significant correlation between interest and cognitive learning outcomes.

The results of this study indicate that the experimental group experienced a higher increase in classical mastery compared to the control group (Figure 2). This suggests that the implementation of blended learning-based guided discovery models successfully increased the number of students who achieved the minimum passing score (≥ 70) compared to those following regular instruction. The e-learning component provides flexibility for students to access assignments and learning materials for self-directed learning, enabling them to be better prepared for face-to-face instruction. Furthermore, face-to-face learning using the guided discovery model allows students to actively engage in the learning process, ultimately enhancing their understanding. Thus, blended learning offers various delivery methods, teaching models, learning styles, and introduces various options for dialogue between facilitators and learners (Hew & Cheung, 2014; Kumar et al., 2021; Rasmitadila et al., 2020).

The cognitive learning outcomes in the experimental class showed improvement with higher N-gain scores compared to the control class (Table 7). This indicates a better understanding of the material by students in the experimental class due to their experience with the guided discovery learning model, which was not experienced by the control class during face-to-face learning. The cognitive constructivist theory by Bruner (1973) supports this research, emphasizing that discovery learning focuses on the active process of students discovering concepts and understanding through real-life examples. Face-to-face learning that centers on students, involving interaction, discussion, and active participation, is crucial for building deep knowledge and understanding among students (Anthony et al., 2022; Clark & Post, 2021; Puspita, 2021). The use of technology in blended learning can also enhance students' interest and motivation in learning. Therefore, the guided discovery-based blended learning model enhances mastery of the material and understanding of material concepts, leading to improved learning outcomes (Bokingo et al., 2022; Romadhon et al., 2020; Wijiastuti & Nurhayati, 2021). Although the N-gain percentage for experimental students is higher than that of the control class, the increase in N-gain is considered moderate. This is because students' understanding of questions at the highest cognitive level is required. These questions demand high-level thinking skills and conceptual understanding. Factors influencing N-gain improvement, such as the use of the learning model, can promote critical thinking, and a supportive learning environment can influence

students' ability in higher-level thinking as a result (Mardi et al., 2021).

In the experimental class, students with high learning interest experienced a significant improvement in their learning outcomes, while students in the control class with low learning interest had suboptimal learning outcome scores. This indicates that learning interest has a positive influence on improving learning outcomes (Chen, 2022; David et al., 2023; Law et al., 2019; Piechurska-Kuciel, 2020). Correlation tests also showed a positive and significant relationship between learning interest and students' learning outcomes. In the face-to-face component of blended learning, the use of the guided discovery model stimulates students' engagement and curiosity, builds high learning interest, and motivates them to learn effectively. Students with high interest are more likely to comprehend the material easily and retain information in long-term memory, which leads to more meaningful learning and better learning outcomes (Mar et al., 2021). Therefore, the level of students' learning interest in learning activities can enhance their learning outcomes (Dahliani et al., 2020; Emefa et al., 2020; Siregar et al., 2022) The correlation between learning interest and learning outcomes is considered moderate because cognitive learning outcomes can be influenced by various other factors, including (1) internal factors such as personal abilities, talents, motivation, attitudes, and study habits; (2) external factors like the physical environment, facilities and infrastructure, social factors, family, community, and school (Spector, 2015).

The implementation of a Guided Discovery model based on Blended Learning

Measurement of the implementation of the guided discovery-based blended learning model was carried out using an observation sheet presented in the Table 3.

Table 10 Recapitulation of the implementation of the guided discovery model based on blended learning

Meeting	Percentage (%)	Criteria
1	83,33	Very high
2	84,62	Very high
3	87,18	Very high
4	100,00	Very high
Average	**88.78**	**Very high**

Table 4.5 shows that the implementation of the guided discovery-based blended learning model in each session has a percentage of over 75%, indicating a very high category of implementation. Therefore, the implementation of the guided discovery-based blended learning model is effectively carried out in the ecosystem subject matter.

The implementation of the guided discovery-based blended learning model was carried out over four sessions. In the first session, students took a pre-test and learned about ecosystem components and the patterns of interaction among them. In the second session, students constructed food webs and projected ecological pyramids. In the third session, students learned about the stages of biogeochemical cycles and the differences between primary and secondary succession. The discovery process involved exploration and observation activities through the internet, which enhanced students' conceptual understanding and digital literacy skills. During face-to-face sessions, students were given initial stimulation to analyze questions in the guided discovery model. They then collaboratively constructed concepts by gathering and processing information in class. Verification was done through presentation of discussion outcomes and interclass question-and-answer sessions. Through sharing, students reinforced their knowledge and drew conclusions from the discussions.

The limited time allocation and the fact that Biology classes in the experimental class took place in the last period resulted in inconsistent and suboptimal face-to-face learning. Students had insufficient time to thoroughly discuss concepts and understand the material well. Additionally, the short class duration restricted teachers' ability to provide reinforcement and review previously taught material. This study is supported by research conducted by Bijlsma et al. (2022), which suggests that conducting face-to-face learning in the last period causes physical and mental fatigue among students, leading to difficulties in concentration and loss of focus during the lesson. The reduction in face-to-face learning hours also leads to a decrease in learning performance (Siemens et al., 2015).

In the first session, students appeared to be unfamiliar with active learning. They faced difficulties in using the syntax of guided discovery due to a lack of prior conceptual understanding. The discovery process also took longer. However, with the guidance of the teacher, students became more active in the final session as they were encouraged to search for and delve into the concepts. This process helped foster a positive learning environment and assisted students in achieving learning objectives effectively. This can be

observed from the students' high level of interest in participating in the learning activities (Figure 4.2). This study aligns with the findings of Rapanta et al. (2020), which demonstrate that student-centered learning requires the important role of teachers in creating an effective learning environment. Additionally, the syntax in the guided discovery model allows students to become more active in discovering concepts with the guidance of the teacher through questioning from a given problem (Invernizzi et al., 2019; Syafyahya & Yades, 2020).

In addition to building students' learning interest, the limitations of the guided discovery model during face-to-face learning can be overcome by incorporating the e-learning component in blended learning. The e-learning component encourages students to acquire conceptual ideas through self-directed learning and hypothesis generation from the problems provided in the LDPD before face-to-face learning. Furthermore, students can repeatedly and flexibly study the material and the LDPD shared by the teacher on the e-learning platform. Thus, the use of blended learning in the guided discovery model can enhance the effectiveness of cognitive learning. Previous research has demonstrated that the e-learning component can enhance self-directed learning, self-efficacy, and strengthen students' initial conceptual understanding and preparedness for face-to-face learning (Arrosagaray et al., 2019; Hrastinski, 2019; Singh et al., 2021).

CONCLUSION

Based on the research findings and discussion, the following conclusions can be drawn.

(1) The implementation of the guided discovery model based on blended learning in the ecosystem subject is effective in stimulating students' learning interest, achieving a high level of criteria.
(2) The implementation of the guided discovery model based on blended learning in the ecosystem subject is effective in enhancing students' learning outcomes.

REFERENCES

Ainley, M. (2017). Interest: Knowns, Unknowns, and Basic Processes. In P. A. O'Keefe & J. M. Harackiewicz (Eds.), *The Science of Interest* (pp. 3–27). Cham, Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-55509-6

Almasri, F. (2022). Simulations to teach science subjects: connections among students' engagement, self-confidence, satisfaction, and learning styles. *Education and Information Technologies*, *27*(5), 7161–7181. https://doi.org/10.1007/s10639-022-10940-w

Anthony, B., Kamaludin, A., Romli, A., Raffei, A. F. M., Phon, D. N. A. L. E., Abdullah, A., & Ming, G. L. (2022). Blended learning adoption and implementation in higher education: a theoretical and systematic review. *Technology, Knowledge and Learning*, *27*(2), 531–578. https://doi.org/10.1007/s10758-020-09477-z

Arrosagaray, M., González-Peiteado, M., Pino-Juste, M., & Rodríguez-López, B. (2019). A comparative study of Spanish adult students' attitudes to ICT in classroom, blended and distance language learning modes. *Computers and Education*, *134*, 31–40. https://doi.org/10.1016/j.compedu.2019.01.016

Arwaty, A., & Lullulangi, M. (2022). Discovery learning model as an effort to increase student interest and learning outcomes. *Journal of Educational Science and Technology (EST)*, *8*(1), 54–64. https://doi.org/10.26858/est.v8i1.35217

Atiyah, U., Miarsyah, M., & Sigit, D. V. (2020). The effect of using e-learning based guided discovery learning model based on self-efficacy towards student learning outcomes in biology class in reproductive system subject in high school. *International Journal for Educational and Vocational Studies*, *2*(9), 789–796. https://doi.org/10.29103/ijevs.v2i9.2732

Ayodele, A. A., & Nasiru, O. I. (2021). Effect of guided-discovery technique on colleges of education social studies students' learning outcome. *Journal of Education and Learning*, *15*(3), 390–396. https://doi.org/10.11591/edulearn.v15i3.20300

Baranova, T., Khalyapina, L., Kobicheva, A., & Tokareva, E. (2019). Evaluation of students' engagement in integrated learning model in a blended environment. *Education Sciences*, *9*(2). https://doi.org/10.3390/educsci9020138

Bijlsma, H. J. E., Glas, C. A. W., & Visscher, A. J. (2022). Factors related to differences in digitally measured student perceptions of teaching quality. *School Effectiveness and School Improvement*, *33*(3), 360–380. https://doi.org/10.1080/09243453.2021.2023584

Bokingo, O., Supartin, S., & Odja, A. H. (2022). The effect of discovery learning models with blended learning strategies assisted by crossword puzzle media on understanding physics concepts. *Science Education Journal (SEJ)*, *6*(1), 35–47. https://doi.org/10.21070/sej.v6i1.1620

Bong, M., Lee, S. K., & Woo, Y.-K. (2015). The Roles of Interest and Self-Efficacy in the Decision to Pursue Mathematics and Science. In K. A. Renninger, M. Nieswandt, & S. Hidi (Eds.), *Interest in Mathematics and Science Learning* (pp. 33–48). Washington,USA: American Educational Research Association.

Boud, D. (2016). *Enhancing Learning Through Self Assessment*. New York: Taylor & Francis. https://doi.org/10.4324/9781315041520

Brata, W. W. W., Wibowo, F. C., & Rahmadina, N. (2021). Implementation of discovery learning in a digital class and its effect on student learning outcomes and learning independence level. *F1000Research*, *10*, 386–398.

https://doi.org/10.12688/f1000research.51763.1
Bruner, J. S. B. (1973). *The Relevance of Education*. Canada: The Norton Library.
Buhl-Wiggers, J., Kjærgaard, A., & Munk, K. (2023). A scoping review of experimental evidence on face-to-face components of blended learning in higher education. *Studies in Higher Education*, *48*(1), 151–173. https://doi.org/10.1080/03075079.2022.2123911
Chen, R. H. (2022). Effects of deliberate practice on blended learning sustainability: a community of inquiry perspective. *Sustainability*, *14*(3), 1785–1800. https://doi.org/10.3390/su14031785
Clark, C. E. J., & Post, G. (2021). Preparation and synchronous participation improve student performance in a blended learning experience. *Australasian Journal of Educational Technology*, *37*(3), 187–198. https://doi.org/10.14742/ajet.6811
Dahliani, E. R., Rahmatan, H., & Djufri. (2020). The correlation between students' interest and learning outcomes in biology. *Journal of Physics: Conference Series*, *1460*(1). https://doi.org/10.1088/1742-6596/1460/1/012072
Emefa, A. J., Miima, F. A., & Bwire, A. M. (2020). Impact of motivation on junior high school students' interest in reading comprehension in Hohoe Municipality: a literature based review. *African Journal of Emerging Issues (AJOEI)*, *2*(8), 1–16. Retrieved from https://ajoeijournals.org/sys/index.php/ajoei/article/view/120
Feudel, F., & Fehlinger, L. (2023). Using a lecture-oriented flipped classroom in a proof-oriented advanced mathematics course. *International Journal of Mathematical Education in Science and Technology*, *54*(1), 46–73. https://doi.org/10.1080/0020739X.2021.1949057
Fives, H., & Susnosky, M. (2017). Fostering a Scientific Approach to Teaching and Learning Deductive and Inductive Teaching. In D. Schwarzer & J. Grinberg (Eds.), *Successful Teaching What Every Novice Teacher Needs to Know*. London: Rowman & Littlefield Publishers.
Gardner, H. (2015). Multiple Intelligences. In *Encyclopedia of Science Education*. New York: Basic Books. https://doi.org/10.1007/978-94-007-6165-0_125-2
Graham, D. A. (2019). Benefits of online teaching for face-to-face teaching at historically black colleges and universities. *Online Learning Journal*, *23*(1), 144–163. https://doi.org/10.24059/olj.v23i1.1435
Hake, R. R. (1999). *Analyzing Change/Gain Scores*. Indiana: Indiana University.
Hew, K. F., & Cheung, W. S. (2014). *Using Blended Learning: Evidence Based Practices*. Cham, Switzerland: Springer.
Hosnan. (2016). *Pendekatan Saintifik dan Kontekstual dalam Pembelajaran Abad 21*. Bogor: Ghalia Indonesia.
Hrastinski, S. (2019). What do we mean by blended learning? *TechTrends*, *63*(5), 564–569. https://doi.org/10.1007/s11528-019-00375-5
Invernizzi, P. L., Crotti, M., Bosio, A., Cavaggioni, L., Alberti, G., & Scurati, R. (2019). Multi-teaching styles approach and active reflection: Effectiveness in improving fitness level, motor competence, enjoyment, amount of physical activity, and effects on the perception of physical education lessons in primary school children. *Sustainability*, *11*. https://doi.org/10.3390/su11020405
Järvelä, S., & Renninger, K. A. (2014). Designing for Learning: Interest, Motivation, and Engagement. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (2nd ed., pp. 668–685). Cambridge, Massachusetts: Cambridge University Press. https://doi.org/10.1017/CBO9781139519526.040
Khodaei, S., Hasanvand, S., Gholami, M., Mokhayeri, Y., & Amini, M. (2022). The effect of the online flipped classroom on self-directed learning readiness and metacognitive awareness in nursing students during the COVID-19 pandemic. *BMC Nursing*, *21*(1), 1–10. https://doi.org/10.1186/s12912-022-00804-6
Kumar, A., Krishnamurthi, R., Bhatia, S., Kaushik, K., Ahuja, N. J., Nayyar, A., & Masud, M. (2021). Blended learning tools and practices: a comprehensive analysis. *IEEE Access*, *9*, 85151–85197. https://doi.org/10.1109/ACCESS.2021.3085844
Law, K. M. Y., Geng, S., & Li, T. (2019). Student enrollment, motivation and learning performance in a blended learning environment: The mediating effects of social, teaching, and cognitive presence. *Computers and Education*, *136*, 1–12. https://doi.org/10.1016/j.compedu.2019.02.021
Ma, X., Ma, X., Li, L., Luo, X., Zhang, H., & Liu, Y. (2021). Effect of blended learning with BOPPPS model on Chinese student outcomes and perceptions in an introduction course of health services management. *Advances in Physiology Education*, *45*(2), 409–417. https://doi.org/10.1152/ADVAN.00180.2020
Mulyasa. (2014). *Pengembangan dan Implementasi Kurikulum 2013*. Badung: PT Remaja Rosdakarya.
Nurhayani, N., Rosnawati, R., & Amimah, T. (2020). Optimization of guided discovery learning models to increase students' interest in mathematics. *Infinity Journal*, *9*(1), 69–80. https://doi.org/10.22460/infinity.v9i1.p69-80
Pekrun, R., & Perry, R. P. (2014). Control-Value Theory of Achievement Emotions. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International Handbook of Emotions in Education* (pp. 120–142). New York: Routledge Taylor & Francis Group. https://doi.org/10.4324/9780203148211
Peraturan Menteri Pendidikan Kebudayaan Riset dan Teknologi Republik Indonesia. (2022). *Peraturan Menteri Pendidikan Kebudayaan Riset dan Teknologi Republik Indonesia Nomor 16 Tahun 2022 tentang Standar Proses Pada Pendidikan Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah*.
Piechurska-Kuciel, E. (2020). *The Big Five in SLA*. Cham, Switzerland: Springer.
Prasetyo, A. D., & Abduh, M. (2021). Peningkatan hasil belajar kognitif melalui model discovery learning tema perkembangan teknologi pada siswa sekolah dasar. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(4), 1830–1837. https://doi.org/10.31004/edukatif.v3i4.677
Puspita, Y. (2021). Application of blended learning (discovery learning, small group discussion, case study, role play & simulation, cooperative learning, and collaborative learning) to improve learning activities and achivements in

lobby and negotiation course. *Advances in Social Science, Education and Humanities Research*, *506*, 441–446. https://doi.org/10.2991/assehr.k.210202.078

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the covid-19 crisis: refocusing teacher presence and learning activity. *Postdigital Science and Education*, *2*(3), 923–945. https://doi.org/10.1007/s42438-020-00155-y

Rasmitadila, Widyasari, Humaira, M. A., Tambunan, A. R. S., Rachmadtullah, R., & Samsudin, A. (2020). Using blended learning approach (bla) in inclusive education course: a study investigating teacher students' perception. *International Journal of Emerging Technologies in Learning*, *15*(2), 72–85. https://doi.org/10.3991/ijet.v15i02.9285

Renninger, K. A., & Hidi, S. E. (2019). Interest Development and Learning. In *The Cambridge Handbook of Motivation and Learning* (pp. 265–290). Cambridge: Cambridge University Press. https://doi.org/10.1017/9781316823279.013

Renninger, K. A., & Hidi, S. E. (2020). To level the playing field, develop interest. *Policy Insights from the Behavioral and Brain Sciences*, *7*(1), 10–18. https://doi.org/10.1177/2372732219864705

Ristanto, R., Sabrina, A., & Komala, R. (2022). Critical thinking skills of environmental changes: a biological instruction using guided discovery learning-argument mapping (gdl-am). *Participatory Educational Research*, *9*(1), 173–191. https://doi.org/10.17275/per.22.10.9.1

Romadhon, M. I., Suprapto, Muhammad, O., & Qomariyah, N. (2020). Instructional design learning: a framework of a blended discovery-project model in electronic engineering. *ACM International Conference Proceeding Series*, 1–4. https://doi.org/10.1145/3377571.3377583

Shin, D. J. D., Lee, H. J., Lee, G., & Kim, S. Il. (2019). The Role of Curiosity and Interest in Learning and Motivation. In S. E. Hidi & K. A. Renninger (Eds.), *The Cambridge Handbook of Motivation and Learning* (pp. 443–464). Cambridge, Massachusetts: Cambridge University Press. https://doi.org/10.1017/9781316823279.020

Siemens, G., Gasevic, D., & Dawson, S. (2015). *Preparing for The Digital University. A Review of The History and Current State of Distance, Blended, and Online Learning*. Canada: Athabasca University Press.

Sinatra, G. M., Broughton, S. H., & Lombardi, D. (2014). Emotions in Science Education. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International Handbook of Emotions in Education* (pp. 415–436). New York: Routledge Taylor & Francis Group. https://doi.org/10.4324/9780203148211

Singh, J., Matthees, B., & Odetunde, A. L. (2021). Leaning online education during COVID-19 pandemic – attitudes and perceptions of non-traditional adult learners. *Quality Assurance in Education*, *29*(4), 408–421. https://doi.org/10.1108/QAE-12-2020-0147

Siregar, F. M. H., Siregar, J., & Lubis, A. P. (2022). Development of chemical equilibrium e-learning content based on guided discovery blended learning for senior high school. *International Journal Of High Information, Computerization, Engineering and Applied Science*, *2*(2), 54–62. https://doi.org/10.24036/jhice/vol2-iss02/58

Skinner, E., Pitzer, J., & Brule, H. (2014). The Role of Emotion In Engagement, Coping, and The Development of Motivational Resilience. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International Handbook of Emotions in Education* (pp. 331–347). New York: Routledge Taylor & Francis Group.

Subagja, S., & Rubini, B. (2023). Analysis of student learning styles using fleming's Vark model in science subject. *Jurnal Pembelajaran Dan Biologi Nukleus*, *9*(1), 31–39. https://doi.org/10.36987/jpbn.v9i1.3752

Sugiyono. (2015). *Metode Penelitian Kombinasi (Mix Methods).* Bandung: Alfabeta.

Syafyahya, L., & Yades, E. (2020). Small group discussion and discovery learning in indonesian course learning. *Advances in Social Science, Education and Humanities Research, 506*, 73–77. https://doi.org/10.2991/assehr.k.210202.015

UNESCO, & IESALC. (2020). *COVID-19 and Higher Education: Today and Tomorrow. Impact Analysis, Policy Responses and Recommendations*. Caracas, Venezuela: IESALC.

Vavasseur, A., Muscari, F., Meyrignac, O., Nodot, M., Dedouit, F., Revel-Mouroz, P., … Mokrane, F. Z. (2020). Blended learning of radiology improves medical students' performance, satisfaction, and engagement. *Insights into Imaging*, *11*(1). https://doi.org/10.1186/s13244-020-00865-8

Widodo, R. P. A., Lisdiana, & Nuswowati, M. (2019). Development of teaching materials based on discovery learning on science lessons with adictive and psychotropic themes in middle school. *Journal of Innovative Science Education*, *8*(3), 349–357. Retrieved from https://journal.unnes.ac.id/sju/index.php/jise/article/view/31079

Wijiastuti, T. N., & Nurhayati, S. (2021). Effectiveness of discovery blended learning on concept understanding and student motivation. *Research Horizon*, *1*(4), 150–156. https://doi.org/10.54518/rh.1.4.2021.150-156

Yunitasari, R., & Hanifah, U. (2020). Pengaruh pembelajaran daring terhadap minat belajar siswa pada masa COVID-19. *Edukatif : Jurnal Ilmu Pendidikan*, *2*(3), 232–243. https://doi.org/10.31004/edukatif.v2i3.142