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Implementation of a Discovery Learning Model Based on Brainstorming in Ecosystem Topics to Develop Critical Thinking Skills of Phase E Students

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Abstract: Critical thinking skills are essential competencies that need to be developed in learning processes, particularly in ecosystem topics that require analytical and problem-solving abilities. This article aims to describe the implementation of a discovery learning model based on the brainstorming method in ecosystem learning to develop critical thinking skills of Phase E students. This study employed a descriptive qualitative approach through the analysis of learning activities and instructional processes. Data were obtained from classroom observations, documentation, and relevant literature studies. The implementation of discovery learning stages integrated with brainstorming activities encouraged students to actively explore problems, generate ideas, analyze information, and formulate conclusions. The findings indicate that the application of a discovery learning model based on brainstorming provides meaningful learning experiences and supports the development of students' critical thinking skills in ecosystem topics. Therefore, this learning model can be used as an alternative instructional approach to foster higher-order thinking skills in biology learning.
Keywords: Discovery Learning; Brainstorming; Critical Thinking Skills; Ecosystem.

Abstrak: *Kemampuan berpikir kritis merupakan salah satu kompetensi penting yang perlu dikembangkan dalam pembelajaran biologi, khususnya pada materi ekosistem yang menuntut kemampuan analisis dan pemecahan masalah. Artikel ini bertujuan untuk mendeskripsikan penerapan model discovery learning berbasis metode brainstorming dalam pembelajaran ekosistem untuk mengembangkan kemampuan berpikir kritis murid fase E. Penelitian ini menggunakan pendekatan deskriptif kualitatif dengan teknik pengumpulan data berupa observasi pembelajaran, dokumentasi, dan kajian pustaka. Penerapan tahapan discovery learning yang dipadukan dengan kegiatan brainstorming mendorong murid untuk aktif mengidentifikasi masalah, mengemukakan ide, menganalisis informasi, serta menarik kesimpulan secara logis. Hasil kajian menunjukkan bahwa penerapan model discovery learning berbasis brainstorming memberikan pengalaman belajar yang bermakna dan mendukung pengembangan kemampuan berpikir kritis murid pada materi ekosistem. Oleh karena itu, model pembelajaran ini dapat digunakan sebagai alternatif pembelajaran untuk mendukung pengembangan keterampilan berpikir tingkat tinggi dalam pembelajaran biologi.*
Kata kunci: *Discovery Learning; Brainstorming; Kemampuan Berpikir Kritis; Ekosistem.*

INTRODUCTION

Education plays a strategic role in developing students' potential in terms of knowledge, attitudes, and skills. Recent studies emphasize that student-centered and inquiry-based learning environments are essential to support higher-order thinking development in science education (Rahmawati & Ridwan, 2022; Widodo & Kadarwati, 2021). One of

the most essential competencies in contemporary education is critical thinking, which enables students to analyze information, evaluate evidence, and make reasoned decisions. Recent studies emphasize that critical thinking is a key competence required to face the challenges of the 21st century, particularly in responding to complex and dynamic global issues (OECD, 2021).

In biology learning, critical thinking skills are highly relevant because biological concepts are closely connected to real-life phenomena and environmental problems. Ecosystem topics, in particular, require students to understand complex interactions between living organisms and their environment and to evaluate environmental issues from multiple perspectives. Learning ecosystem concepts through contextual and inquiry-based approaches has been shown to support deeper understanding and critical thinking development (Pratiwi & Sunaryo, 2022; Sari & Lestari, 2022). Facione (2020) explains that critical thinking involves interpretation, analysis, evaluation, inference, and explanation, all of which are fundamental skills in understanding ecosystem concepts.

However, several recent studies report that learning practices in schools are still dominated by teacher-centered approaches that focus on content mastery rather than the development of higher-order thinking skills. This condition limits students' opportunities to actively engage in inquiry and critical analysis (Sani, 2022). Therefore, learning models that actively involve students in constructing knowledge are urgently needed.

One learning model that aligns with this need is discovery learning. Several studies in biology education report that discovery learning can effectively support students' critical thinking skills when implemented through well-structured learning stages (Hidayati & Wulandari, 2021; Anwar & Harmi, 2020). Discovery learning encourages students to explore, investigate, and discover concepts independently through structured learning stages. According to Kemendikbud (2022), discovery learning supports student-centered learning and promotes critical and analytical thinking by engaging students directly in the learning process. To further enhance student participation and idea generation, discovery learning can be integrated with the brainstorming method.

The brainstorming method provides students with opportunities to express ideas freely, discuss problems collaboratively, and consider various alternative solutions. Research findings indicate that brainstorming techniques encourage active participation and foster critical thinking through idea generation and argumentation processes (Nurhayati & Hasanah, 2020; Fitriani & Nugroho, 2021). Recent educational research highlights that brainstorming activities can foster students' critical and creative thinking by encouraging open discussion and active participation (Putri & Suryadi, 2021). When brainstorming is integrated into discovery learning stages, students are more actively involved in analyzing problems, evaluating information, and formulating logical conclusions.

Based on these considerations, this article aims to describe the implementation of a discovery learning model based on the brainstorming method in ecosystem learning as an effort to develop critical thinking skills of Phase E students. This study is expected to contribute to improving biology learning practices and provide an alternative instructional approach that supports the development of students' higher-order thinking skills.

Although numerous studies have examined the effectiveness of discovery learning and

the brainstorming method in improving students' critical thinking skills, most of these studies tend to discuss each approach separately. Research that explicitly integrates discovery learning with brainstorming is still limited, particularly studies that provide a descriptive and implementative account of how both strategies are combined in real classroom practices. Therefore, there is a need for descriptive implementation-based studies that clearly explain the stages, learning activities, and pedagogical rationale underlying the integration of discovery learning and brainstorming. Addressing this gap, the present study focuses on describing the practical implementation of a discovery learning model integrated with the brainstorming method in ecosystem learning to support the development of students' critical thinking skills.

METHOD

This study employed a descriptive qualitative approach focusing on the implementation of a discovery learning model integrated with the brainstorming method in ecosystem learning. This approach was selected to systematically describe the learning process and its contribution to the development of students' critical thinking skills without aiming to test causal relationships.

The study was conducted at SMAN 1 Palembayan. The research subjects consisted **of** one class of Phase E students totaling 36 students**,** who participated directly in ecosystem learning activities using the discovery learning model based on the brainstorming method. The selection of subjects was based on their active involvement in the learning implementation and their relevance to the research focus.

Data collection techniques included classroom observations, documentation, and literature review**.** Classroom observations were carried out using a non-participant observation technique**,** in which the observer did not intervene in the learning process. The observations focused on the implementation stages of discovery learning, students' engagement during brainstorming activities, interaction patterns, and indications of critical thinking behaviors. Observation data were recorded using structured field notes, consisting of three main components: (1) a description of learning activities and classroom situations, (2) records of students' responses and interactions, and (3) reflective notes related to critical thinking indicators.

The implementation of the learning model was conducted over three meetings, each lasting 2 × 45 minutes**,** covering ecosystem subtopics such as ecosystem components, energy flow, and environmental interactions. This duration allowed for repeated observation of the learning stages and students' participation patterns.

The observer in this study was the researcher, supported by a biology subject teacher as a peer observer to enhance data credibility. This collaboration enabled cross-checking of observation results and reduced subjectivity.

Documentation was used to support observation data, including lesson plans, teaching materials, student worksheets, and samples of students' learning products generated during the brainstorming and discovery activities. In addition, relevant literature was reviewed to strengthen the theoretical basis of the analysis.

Data analysis followed qualitative descriptive procedures, including data reduction, data display, and conclusion drawing**.** Data validity was ensured through triangulation of data sources and observation results**.** The findings were presented descriptively to provide a

comprehensive overview of the implementation of discovery learning based on the brainstorming method in supporting the development of critical thinking skills of Phase E students in ecosystem learning.

RESULT AND DISCUSSION

Findings

The implementation of the discovery learning model based on the brainstorming method was carried out through systematic learning stages, including stimulation, problem identification, data collection, data processing, verification, and conclusion drawing. At the stimulation stage, students were presented with contextual ecosystem phenomena such as environmental pollution and ecosystem imbalance found in their surroundings. Students responded by relating these phenomena to real conditions in their daily lives, which indicates their ability to interpret information and activate prior knowledge as an initial component of critical thinking (Facione, 2020).

During the problem identification stage, brainstorming activities were integrated to encourage students to express ideas freely. Classroom observations showed that students were more confident in conveying opinions, asking questions, and responding to peers' ideas. For example, during group discussions, students proposed various causes of ecosystem imbalance and refined their ideas after listening to alternative viewpoints. This interaction illustrates students' analytical thinking and openness to multiple perspectives, which are essential elements of critical thinking development (Nurhayati & Hasanah, 2020; Fitriani & Nugroho, 2021).

In the data collection stage, students collaboratively gathered information from textbooks, teacher-provided materials, and group discussions. Brainstorming supported students in generating diverse ideas and alternative explanations related to ecosystem problems. Subsequently, in the data processing stage, students organized and analyzed the collected information by comparing different viewpoints and categorizing data into causes, impacts, and solutions. These activities reflect evaluative and inferential thinking processes, as students distinguished relevant information and drew logical connections between data and conclusions (Pratiwi & Sunaryo, 2022; Sari & Lestari, 2022).

At the verification stage, students were guided to examine the accuracy of information and arguments developed during discussions. Some students justified their conclusions by referring to evidence discussed earlier, while others revised their initial assumptions after receiving feedback from peers. In the conclusion drawing stage, students synthesized information and formulated group conclusions based on discussion results. This process demonstrates higher-order thinking skills, including explanation and reflective thinking, as described by Facione (2020).

To clarify the relationship between the discovery learning stages, the integration of brainstorming activities, and critical thinking aspects, the implementation process is summarized in Table 1.

Table 1. Implementation of Discovery Learning Based on Brainstorming and Critical Thinking Skills

Discovery Learning Stage	Learning Activities	Brainstorming Integration	Critical Thinking Aspect

Stimulation	Observing ecosystem phenomena	Sharing initial ideas	Interpretation
Problem Identification	Identifying ecosystem problems	Generating ideas in groups	Analysis
Data Collection	Searching for information	Exchanging viewpoints	Evaluation
Data Processing	Organizing and analyzing data	Group discussion	Inference
Verification	Justifying findings	Clarifying arguments	Explanation
Conclusion Drawing	Formulating conclusions	Building group consensus	Conclusion

As shown in Table 1, each stage of discovery learning integrated with brainstorming corresponds to specific critical thinking aspects, including interpretation, analysis, evaluation, inference, explanation, and conclusion drawing. The table illustrates how systematic learning stages provide structured opportunities for students to engage in critical thinking throughout ecosystem learning.

Discussion

The findings indicate that the integration of discovery learning and brainstorming created a more active and student-centered learning environment compared to conventional teacher-centered instruction. Students were not only involved in discovering ecosystem concepts independently but also actively engaged in exchanging ideas and perspectives with peers. This learning atmosphere supports the development of critical thinking skills, as students were trained to analyze problems, evaluate information, and justify conclusions. These findings are consistent with previous studies reporting that inquiry-based and collaborative learning strategies contribute positively to students' critical thinking development in biology learning (Susanti & Prasetyo, 2020; Yuliana & Arifin, 2021; Sani, 2022).

However, the implementation also revealed several challenges. Brainstorming activities did not engage all students equally, as some students tended to dominate discussions while others remained passive. This dominance limited the diversity of ideas explored during group discussions and reduced opportunities for quieter students to contribute. Similar limitations of brainstorming have been noted in previous studies, which emphasize the need for structured facilitation to ensure balanced participation (Putri & Suryadi, 2021).

In addition, students' ability to construct evidence-based arguments during the verification stage was still relatively weak. Some conclusions were based on general opinions rather than explicit data, indicating that students require further guidance in linking claims with supporting evidence. This finding suggests that while discovery learning supports inquiry and exploration, explicit scaffolding is still needed to strengthen students' argumentation skills.

The effectiveness of the integrated learning model was highly dependent on teacher facilitation. The teacher played a crucial role in managing discussion dynamics, guiding brainstorming activities, and encouraging students to connect ideas with evidence. Without adequate facilitation, brainstorming activities risk becoming unfocused or dominated by a few students, reducing their effectiveness in supporting critical thinking development (Kemendikbud, 2022).

Furthermore, the school context may have influenced the implementation results. Students' prior learning experiences, classroom culture, and limited instructional time affected their readiness to engage in inquiry-based and discussion-oriented learning. These contextual factors should be considered when interpreting the findings. Despite these limitations, the results suggest that the discovery learning model based on brainstorming provides meaningful learning experiences and has the potential to support the development of critical thinking skills of Phase E students in ecosystem learning, in line with findings from recent educational research (Sani, 2022; Kemendikbud, 2022).

CONCLUSION

Based on the results and discussion, this study concludes that the implementation of a discovery learning model integrated with the brainstorming method can be described as a learning approach that facilitates active student engagement during ecosystem learning. Through systematic stages of discovery learning, students were observed participating in problem identification, information exploration, idea exchange, and conclusion formulation. These activities illustrate how the learning process provides opportunities for students to engage in critical thinking-related behaviors without making claims of measured improvement.

The integration of brainstorming within the discovery learning stages allowed students to express ideas, consider multiple perspectives, and justify arguments during classroom interactions. Observations indicate that students demonstrated behaviors associated with critical thinking processes, such as interpretation, analysis, evaluation, inference, and explanation, as conceptualized by Facione (2020). However, these findings are descriptive in nature and do not indicate causal relationships or quantify changes in students' critical thinking skills.

This study also acknowledges several limitations. The implementation was conducted within a specific school context and involved a limited number of learning sessions, which may influence the observed learning dynamics. Brainstorming activities did not engage all students equally, as some students tended to dominate discussions, while others were less active. In addition, the success of the learning process was highly dependent on teacher facilitation in guiding discussions and ensuring balanced participation.

Therefore, this study does not claim the effectiveness of the discovery learning model based on brainstorming but rather provides a descriptive account of its classroom implementation. The findings may serve as a reference for educators and researchers interested in applying or further investigating integrative learning models to support critical thinking development, particularly through more rigorous designs in future studies.

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