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# The Implementation of the Discovery Learning Model Using Higher Order Thinking Skills Booklet Media on Students' Critical Thinking Ability

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**ABSTRACT**

**Objectives:** To implement and design learning models that incorporate appropriate instructional media, fostering critical thinking. Such an approach will facilitate the integration of three cognitive domains: knowing, applying, and reasoning. **Methods:** This study adopts a quasi-experimental design using a "true experimental design" with a post-test-only control group. The objective is to implement the Discovery Learning model and develop a Higher-Order Thinking Skills (HOTs) booklet to enhance students' critical thinking abilities. **Results:** The research findings indicate that the Discovery Learning model with HOTs booklet media significantly influences students' critical thinking skills in biology learning. The critical thinking aspect with the highest score is essential clarification, effectively fostered during the problem-orientation phase. This stage involves students formulating questions based on scenarios in their worksheets. **Novelty:** The novelty of this study lies in its integration of Discovery Learning with a hots booklet explicitly tailored to the Indonesian secondary school context. While previous studies have emphasized the individual impact of Discovery Learning or HOTs-based instructional tools, this research uniquely combines the two to create a synergistic approach that addresses the critical thinking gaps identified in Indonesian students.

## INTRODUCTION

In the 21st century, students must develop critical thinking skills, considered essential learning outcomes. Achieving these outcomes is contingent upon implementing effective learning processes (Hidayat et al., 2024). However, several studies on secondary school students in Indonesia indicate that critical thinking skills still require significant improvement (Chairatunnisa et al., 2023; Chusni et al., 2022; Lestari et al., 2021; Suastrawan et al., 2021) These skills can be enhanced by applying practical and meaningful instructional models. Such models foster an environment where students can construct their knowledge based on real-life experiences. The instructional models that support this are Discovery Learning and the Higher Order Thinking Skills (HOTs) booklet (Suriano et al., 2025).

Discovery Learning is an instructional method in which students independently investigate, build upon prior experiences and knowledge, utilize intuition, imagination, and creativity, and seek new information to uncover facts, relationships, and truths (Aldalur & Perez, 2023). In this process, learning is not merely absorbing information but involves students actively seeking answers and solutions (Hoerudin, 2023; Pujiana et al., 2024). As educational expert Rusman asserts, Discovery Learning encourages individuals and groups to discover knowledge through hands-on experience.

Furthermore, according to the Indonesian Ministry of Education and Culture Regulation No. 22 of 2016, Discovery Learning is a problem-based learning method that aims to develop practical project assessment tools and innovative operational assessments. The method is designed around experiential and interactive activities, where educators actively engage students in constructing knowledge, skills, values, and attitudes through direct experiences. Teachers employ storytelling, games, visual aids, and various techniques to stimulate students' curiosity and guide them toward novel ways of thinking, acting, and reflecting (Manurung & Pappachan, 2025).

A range of techniques can be applied within the Discovery Learning framework; however, the objective remains consistent: to enable students to achieve learning outcomes through direct experiences and independent learning processes (Qudratuddarsi et al., 2022). By exploring and manipulating situations or conducting experiments, students are more likely to retain concepts and acquire new knowledge (Asad et al., 2021; Chen et al., 2023; Ng et al., 2022). Discovery Learning can be implemented individually or in groups, incorporating activities such as group discussions, projects, simulations, or experiments (Santiani et al., 2024). As a designed learning resource, a booklet can be crucial in developing reasoning skills, a core component of HOTs. Learning activities should challenge students to engage in critical thinking to foster higher-order thinking.

Paul (2022) argues that training students in higher-order thinking helps them comprehend information, think critically, and achieve high-quality outcomes, fostering independence. Booklets or brochures can serve as effective instructional media derived from the core competencies students must master, focusing on one particular competency to avoid overwhelming students with excessive content (Ramadhana & Qudratuddarsi, 2024). Visual aids such as diagrams, fishbone charts, tables, and various questions in HOT development of higher-order thinking.

Research by Hashemi (2019) demonstrates the significant impact of using V-diagrams in biology education on students' critical thinking abilities. Similarly, Bahr and Lloyd (2019) found that varied higher-order questions positively affect students' thinking skills and can assess their cognitive levels. Critical thinking is one of the essential 21st-century skills. It involves analyzing and evaluating relevant information, using ideas effectively, thinking critically, and communicating efficiently with others (Rohmah & Prahani, 2021; Saphira & Prahani, 2022). Furthermore, critical thinking entails engaging in mental activities for problem-solving and emphasizes reasoned and reflective decision-making (Le & Nguyen, 2024; Lin et al., 2021; Orhan, 2022; Verawati & Sarjan, 2023). Students who struggle with decision-making may lack confidence rather than knowledge or skills. A survey conducted in secondary schools in Bengkulu revealed an average critical thinking score of 45.02, which was classified as low. Students struggled to formulate problems, draw logical conclusions, and develop effective strategies. Similar research across various educational levels in Indonesia underscores the need for improved critical thinking skills, necessitating the adoption of appropriate learning strategies.

The novelty of this study lies in its integration of Discovery Learning with a higher-order thinking Skills (HOTs) booklet explicitly tailored to the Indonesian secondary school context. While previous studies have emphasized the individual impact of Discovery Learning or HOTs-based instructional tools, this research uniquely combines the two to create a synergistic approach that addresses the critical thinking gaps

identified in Indonesian students. Additionally, the study incorporates culturally and contextually relevant materials aligned with national education regulations. By employing innovative techniques, such as visual aids, interactive diagrams, and contextualized problem-solving tasks, this research seeks to establish a new instructional model that enhances critical thinking skills and provides practical guidelines for educators in implementing similar strategies across diverse learning environments.

## RESEARCH METHOD

This study is a quasi-experimental research using a "true experimental design," specifically the post-test-only control design, as shown in Table 1.

**Table 1.** The research design is non-equivalent to the pretest-posttest control group design.

| Class | Treatment | Post-test |
|---|---|---|
| Experiment | Applied Discovery Learning learning model with **Higher Order Thinking Skill Booklet media** | Evaluation test |
| Control | Applied conventional learning | Evaluation test |

The population of this study consists of students from class XI Science 2 and XI Science 3 at Senior High School 1 Majene, Majene Regency, for the 2023/2024 academic year. The sample was selected using a simple random sampling technique, resulting in one control and one experimental class, each with 35 students. The experimental class received treatment using the Discovery Learning model with HOTS booklet media, while the control class underwent conventional learning without media. This study includes one independent variable: implementing the Discovery Learning model using HOTS booklet media. The dependent variable is the student's learning outcomes.

Data collection techniques involved tests and questionnaires. Test scores were obtained through a post-test (Qudratuddarsi et al., 2024). The research instruments included learning materials (syllabus, lesson plans, and the Booklet), a critical thinking skills test, and student response questionnaires regarding the Discovery Learning model with HOTS booklet media and the Booklet itself. Data analysis involved normality testing, homogeneity testing, two-mean comparison tests, and learning mastery tests (Qudratuddarsi et al., 2019).

## RESULTS AND DISCUSSION

### *Results*

The research results cover students' critical thinking skills, their responses to implementing the Discovery Learning model using HOTS booklet media, and their responses to the HOTS booklet. Data on critical thinking skills were obtained through students' completion of essay tests. These essay questions measured various indicators of critical thinking skills, including essential clarification, bases for a decision, inference, advanced clarification, supposition and integration, and strategies and tactics. A comparison of students' critical thinking skill scores between the experimental class and the conventional class can be seen in Table 2.

**Table 2.** Students' critical thinking skills scores

| Indicator Problem-solving skills | | Class | |
|---|---|---|---|
| | | **Experiment** | **Conventional** |
| **Basic clarification** | Score | 88.00 | 45.00 |
| | Criteria | Good | Very Insufficient |
| **Bases for a decision** | Score | 85.00 | 40.00 |
| | Criteria | Good | Very Insufficient |
| **Inference** | Score | 85.00 | 60.00 |
| | Criteria | Good | Insufficient |
| **Advanced clarification** | Score | 79.00 | 45.00 |
| | Criteria | Fairly good | Very insufficient |
| **Supposition and integration** | Score | 77.00 | 40.00 |
| | Criteria | Fairly good | Very insufficient |
| **Strategies and tactic** | Score | 85.00 | 60.00 |
| | Criteria | Good | Sufficient |
| **Average** | | 83.17 | 48.27 |

Table 2 shows that the achievement of all critical thinking skill indicators in the experimental class is higher (83.17) than in the conventional class (48.27) for the basic clarification indicator. In contrast, the supposition and integration indicator has the lowest score. The effect of the instructional model on critical thinking skills was analyzed using ANCOVA. The results of the ANCOVA test are presented in Table 3.

**Table 3.** The results of the ANCOVA test on the influence of the Discovery Learning model with HOTS booklet media on critical thinking skills.

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 18603.43[a] | 4 | 4650.85 | 75.70 | .00 |
| Intercept | 34594.70 | 1 | 34594.70 | 563.13 | .00 |
| Critical | 38.34 | 1 | 38.34 | .62 | .43 |
| Class | 18519.96 | 3 | 6173.32 | 100.48 | .00 |
| Error | 5713.25 | 93 | 61.43 | | |
| Total | 503159.65 | 98 | | | |
| Corrected Total | 24316.68 | 97 | | | |

The ANCOVA test results indicate that the calculated F-value for the difference in instructional models is 100.48, with a p-value of 0.00. Since the p-value < α (α = 0.05), this signifies a significant effect of the instructional model on students' critical thinking skills. Based on these hypothesis test results, an LSD (Least Significant Difference) test was conducted, and the results are presented in Table 4.

**Table 4.** Results of the LSD test on critical thinking skills.

| Class | Pretest | Posttest | Range | Progress | Connected average | Notation |
|---|---|---|---|---|---|---|
| Conventional | 23.39 | 48.27 | 24.87 | 106.34% | 48.15 | A |
| Experiment | 22.75 | 83.18 | 60.43 | 265.61% | 82.99 | c |

The LSD test results indicate a significant difference between the conventional class and the experimental class. The experimental class has the highest adjusted mean score of 82.99, compared to 48.15 in the conventional class.

***Discussion***

The research findings indicate that the Discovery Learning model with HOT booklet media significantly influences students' critical thinking skills in biology learning. The critical thinking aspect with the highest score is essential clarification, effectively fostered during the problem-orientation phase. This stage involves students formulating questions based on scenarios in their worksheets. For example, students were given a scenario about the Nemathelminthes species, such as *Ascaris lumbricoides*, which causes parasitic infections in children. Students formulated relevant questions from this scenario, such as, "Why does this worm cause parasitic infections?" These student-generated questions demonstrate that the basic clarification indicator was optimally achieved. Essential clarification involves defining problems accurately, clearly, and precisely, making them easier to understand. This finding aligns with the research by Duron et al. (2016), which concluded that critical thinking skills improve significantly during the problem-formulation stage.

In addition to essential clarification, the indicator "bases for a decision" also achieved a high score. Bases for a decision were effectively fostered during the investigation/observation phase of the learning process. This phase involved students gathering information to verify their hypotheses by exploring various learning resources to obtain explanations. For example, students were asked to answer, "How can we prevent the extinction of invertebrates? This can be achieved by avoiding excessive exploitation of invertebrate species, implementing conservation efforts, and enforcing integrated law in the judicial process by issuing a circular regarding handling wildlife crimes. According to Masek and Yamin (2021), the basis for a decision is the ability to evaluate the credibility of sources and the ability to interpret and assess the information obtained.

Research by Irwanto et al. (2018) shows that students can build their skills by exploring problems through group discussions with peers and teachers and applying concepts based on their acquired sources. The explanation phase is another advantage of the Discovery Learning model with HOT booklet media. During this phase, the indicator of critical thinking skills, inference, is effectively fostered, with high scores. Students are actively engaged in group discussions to conclude by comparing their initial predictions with the results of their observations. Students are asked to answer questions and make conclusions about specific situations. For example, "Conservation Director Jonathan Baillie provided data that 12,621 invertebrate species are threatened with extinction." Students were able to make correct conclusions based on the facts provided. The students' conclusions indicate that the inference indicator's achievement was optimal. Inference involves identifying and drawing reasonable conclusions by considering relevant information. Group discussions and providing arguments offer students opportunities to think critically. Moreover, group discussions and the exchange of opinions among students also influence decision-making considerations.

In addition to inference, the explanation phase also plays a key role in training the "strategies and tactics" indicator. During this phase, students are asked to determine the solutions to the presented problem. For example, when presented with the following question: "A student finds an animal on the beach. The teacher says that the animal

belongs to the Crustacea group. The student wants to prove whether this animal is indeed a Crustacea. What should you do to prove this animal is part of the Crustacea group?" Based on the question, students could answer effectively by proposing various strategic solutions to confirm that the animal belongs to the Crustacea group, such as observing its body characteristics, habitat, number of legs, and mode of locomotion. The strategies and tactics proposed by the students demonstrate that this indicator was successfully achieved. Appropriate strategies and tactics may involve using strategies to clarify or simplify the problem, organizing arguments, and determining and deciding on actions to solve problems while considering existing criteria (Mogea, 2023; Sahoo & Goswami, 2023; Yüksel et al., 2023; Zhang et al., 2024). Students' critical thinking skills improve when they engage in activities that explore phenomena, utilize various sources to seek solutions to problems, and determine the appropriate solutions.

The aspects of critical thinking skills that scored fairly well were advanced clarification supposition and integration. Both of these indicators were also developed during the explanation phase. Students were asked to explain the problem by providing answers based on the theories and facts they gathered. For instance, students were presented with two images of seed-bearing plant groups (Spermatophyta), specifically the Angiospermae and Gymnospermae groups. They were then asked to analyze and draw conclusions about the two images. Based on this issue, students could construct arguments and provide answers consistent with theory and facts. Advanced clarification is providing and evaluating definitions of terms and identifying assumptions related to the information obtained. Critical thinking skills in advanced clarification were significantly higher in the experimental group compared to the control group.

Regarding supposition and integration, students were actively engaged in discussions to consider and provide valid reasons for the questions posed. In this study, students were asked, "Nitrogen is an essential element for living organisms. This is because nitrogen is a component of proteins and nucleic acids. What role do bacteria play in the nitrogen cycle?" Students were able to answer the question correctly because they logically explored the role of bacteria in the nitrogen cycle, linking their understanding of nitrogen theory with the role bacteria play in the cycle.

In this context, students were able to effectively achieve supposition and integration. Supposition and integration are related to determining the relevance of information and logically thinking through solutions to problem-solving. Students could integrate theory with facts, but the quality of their reasoning was still reasonably good. This is greatly influenced by the cognitive abilities that students already possess.

The advanced clarification sup, position, and integration indicators show improvement. However, enhancing these two indicators is still in the "fair" category, indicating that further development is needed. Additional time should be allocated to applying the learning syntax to optimize these indicators. The goal is to ensure more effective engagement with advanced clarification supposition and integration indicators. Moreover, teachers need to provide more optimal guidance to students, helping them develop more confidence in their abilities to complete tasks successfully.

Based on the LSD test, the Discovery Learning model with the HOTs Booklet showed a significant difference in fostering critical thinking skills compared to the conventional class. Every phase of Discovery Learning with the HOTs Booklet contributes to developing students' critical thinking skills by analyzing phenomena, making

deductions and inductions from various information sources, and making sound decisions about potential solutions. Activities like analyzing the causes and solutions to problems, presenting information, and drawing conclusions are essential for empowering students' critical thinking (Ramadhana et al., 2023). Critical thinking skills can be achieved through exploring and analyzing scientific phenomena, discussions, and peer collaboration.

In traditional teaching methods, however, teachers often fail to empower students' critical thinking skills. In these methods, the teacher transfers knowledge to students without encouraging reflection. Additionally, the questions posed by the teacher do not always align with the critical thinking indicators. This finding aligns with research by Ramadhana (2024), which concludes that traditional teaching methods are less effective in fostering students' critical thinking skills. The questions teachers ask often do not push students toward analysis, synthesis, and evaluation. The use of active learning strategies as a solution to better empower students' critical thinking skills.

## CONCLUSION

**Fundamental Finding:** When combined with the HOTs Booklet, the Discovery Learning model effectively enhances students' critical thinking abilities. This is achieved through engaging students in processes such as analyzing phenomena, drawing deductions and inductions from various information sources, and making well-informed decisions regarding potential solutions. This pedagogical approach has improved critical thinking skills among students in class XI Science at Senior High School 1 Majene. **Implications:** Biology educators are encouraged to adopt the Discovery Learning model paired with the HOTs Booklet, as this method has significantly enhanced students' critical thinking skills. By employing this instructional strategy, teachers can foster a more dynamic and participatory learning environment that encourages profound cognitive development and facilitates critical engagement with the subject matter. **Limitations:** The implementation of the Discovery Learning model with the HOTS Booklet has, to date, been restricted to specific topics, including Plantae, Animalia, Ecosystems, and Environmental Changes. As such, its application has been limited to these particular areas, and further exploration is needed to determine its generalizability across a broader range of subjects and educational contexts. **Future Research:** Future studies in education should consider further refining the Discovery Learning model in conjunction with the HOTS Booklet by addressing its strengths and weaknesses. Researchers are encouraged to explore its application in various subjects and diverse educational settings. Such inquiries will expand the model's applicability and enhance the existing body of knowledge, offering valuable insights for improving pedagogical practices in critical thinking development.

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