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SYSTEMATIC LITERATURE REVIEW: THE IMPLEMENTATION OF THE DISCOVERY LEARNING MODEL TO IMPROVE BIOLOGY LEARNING OUTCOMES IN HIGH SCHOOL

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ABSTRACT

Education is a crucial aspect in creating high-quality human resources. The appropriate learning model, such as Discovery Learning, plays a vital role in enhancing student learning outcomes, particularly in Biology at the high school level. Discovery Learning emphasizes the process of concept discovery by students through active learning activities, helping them build knowledge independently and meaningfully. This study aims to evaluate the effectiveness of the Discovery Learning model in improving high school biology learning outcomes through a systematic literature review using the PRISMA method. The analysis of seven articles that met the criteria shows that Discovery Learning significantly enhances high school students' biology learning outcomes. These findings highlight the effectiveness of Discovery Learning in deepening students' understanding of biological concepts and increasing their motivation.

Keywords: *discovery learning, learning outcomes, biology*.

ABSTRAK

Pendidikan merupakan aspek penting dalam upaya menciptakan sumber daya manusia yang berkualitas. Model pembelajaran yang tepat, seperti Discovery Learning, menjadi krusial dalam meningkatkan hasil belajar siswa, terutama pada mata pelajaran Biologi di tingkat Sekolah Menengah Atas (SMA). Discovery Learning menekankan pada proses penemuan konsep oleh siswa melalui kegiatan aktif, membantu mereka membangun pengetahuan secara mandiri dan bermakna. Penelitian ini ditunjukan mengevaluasi efektivitas model pembelajaran Discovery Learning dalam meningkatkan hasil belajar biologi SMA melalui tinjauan literatur sistematis menggunakan metode PRISMA. Analisis terhadap tujuh artikel yang memenuhi kriteria menunjukkan bahwa Discovery Learning secara signifikan meningkatkan hasil belajar biologi siswa SMA. Hasil ini menyoroti efektivitas Discovery Learning dalam memperdalam pemahaman konsep biologi dan meningkatkan motivasi siswa.

Kata kunci: discovery learning, hasil belajar, biologi.

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I. INTRODUCTION

Education plays a critical role in shaping high-quality human resources, with one of the key factors being the implementation of an effective and engaging learning process (Anderson, 2020; Oliver & Trigwell, 2005). In high school Biology education, selecting an appropriate instructional model is crucial to enhancing student learning outcomes, especially when addressing complex and abstract topics such as human anatomy and ecosystems (Gormally et al., 2012). The Discovery Learning model has gained increasing attention as a pedagogical approach that fosters active student participation in the learning process, allowing them to construct knowledge independently through inquiry-based activities (Alfieri et al., 2011; Mayer, 2004).

Discovery Learning is rooted in constructivist theory, emphasizing that students learn best when they actively engage in problem-solving and experimentation (Bruner, 1961; Harlen & Qualter, 2018). This model encourages students to discover concepts independently, thus promoting deeper understanding and long-term retention of knowledge (Hmelo-Silver et al., 2007). In the context of high school Biology, several studies have demonstrated that Discovery Learning can significantly improve student outcomes, especially in topics like human digestive and respiratory systems (Areepattamannil et al., 2015; Zohar & Dori, 2003; Chen et al., 2019). For example, Suardana et al. (2017) found that the implementation of Discovery Learning in human digestive system lessons resulted in a substantial improvement in student comprehension. Similarly, Wati and Suarni (2019) reported positive effects on student learning in respiratory system topics using this approach.

In addition to promoting deeper understanding, Discovery Learning aligns with the principles of experiential learning, where students engage in hands-on activities that connect theoretical knowledge with practical experience (Kolb & Kolb, 2005). This approach fosters critical thinking and problem-solving skills, which are essential for success in STEM fields (Gijbels et al., 2005; DeHaan, 2005). As students explore and experiment, they develop a deeper connection with the material, leading to improved academic performance (Schmidt et al., 2009; Loyens & Rikers, 2011). Furthermore, Discovery Learning has been shown to increase student motivation and engagement, as it shifts the focus from passive learning to active participation (Dumont et al., 2010; Gijbels et al., 2006).

However, while the benefits of Discovery Learning are well-documented, its implementation can be challenging. One of the main obstacles is the increased time required for planning and execution compared to traditional teaching methods (Kirschner et al., 2006; Prasetyo et al., 2020). Teachers need to carefully design learning activities that guide students toward the intended learning outcomes without providing direct answers (Cheng et al., 2018). Additionally, the diverse learning abilities of students can present difficulties in ensuring that all learners benefit equally from this approach (Minner et al., 2010). As Gijbels et al. (2005) note, Discovery Learning requires significant scaffolding to ensure that students with varying levels of prior

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knowledge can successfully navigate the learning process.

To address these challenges, it is important to investigate how Discovery Learning can be effectively integrated into Biology education. A systematic review of the literature can provide valuable insights into how this model has been applied, its impact on student outcomes, and the strategies educators can use to overcome potential barriers (Loyens et al., 2008; De Jong & Van Joolingen, 1998). By synthesizing the findings from previous studies, this review aims to identify best practices for implementing Discovery Learning in high school Biology classrooms and to offer recommendations for future research in this area.

II. METHODS

This study employs the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method to conduct a systematic literature review. The inclusion criteria for studies are those that examine the implementation of the Discovery Learning model in high school biology, published in either Indonesian or English, designed as experimental or quasi-experimental studies, and report learning outcomes as one of the variables. Studies that do not focus on biology or high school education, are published in languages other than Indonesian or English, are non-experimental, or do not clearly report learning outcome data will be excluded from this review.

The literature search was conducted across several databases, including PubMed, Google Scholar, ERIC, Scopus, and local repositories like Garuda. The search strategy utilized a combination of keywords and phrases such as "Discovery Learning", "learning outcomes", "biology", "high school", "effectiveness", and "instructional model". Two independent reviewers will screen the titles and abstracts of identified studies, followed by a full-text review to determine the studies' eligibility. Any disagreements will be resolved through discussion or by involving a third reviewer.

Data will be extracted using a standardized form that includes information on the author, year of publication, study design, population, instructional methods used, and reported learning outcomes. A PRISMA flow diagram will be included to show the number of studies identified, screened, and included in the review, as well as the reasons for study exclusion. The results of the qualitative and quantitative synthesis will be presented, including tables and graphs. By following this method, it is expected that this systematic review will provide a comprehensive overview of the effectiveness of the Discovery Learning model in improving biology learning outcomes at the high school level.

III. RESULTS AND DISCUSSION

Seven scientific articles related to the application of the Discovery Learning model in biology education have been collected and analyzed. The research findings from these articles are presented in Table 1 below.

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No	Researchers and Year	Title and Journal	Research Findings
1	Ultri Asih Nur'aini, Rahmawati Darusyamsu. 2022	Peningkatan Hasil Belajar Biologi Peserta Didik SMA dengan Penerapan Model Pembelajaran Discovery Learning. Biodidaktika: Jurnal Biologi dan Pembelajarannya	The pretest results showed that both classes had similar student learning outcomes, with an average score of 28.66 for the experimental class and 27.09 for the control class. After applying different learning models, the posttest results showed significant improvement. The average posttest score for the experimental class was 80.43, while for the control class it was 74.87. Statistical analysis showed a significant difference between the two sample groups.
2	Megawati, Sri. 2022	Penerapan Model Discovery Learning Dalam Menuntaskan Hasil Belajar Siswa Pada Mata Pelajaran Biologi. Nosarara: Jurnal Pendidikan Dan Ilmu Sosial	The results of the study showed that in Cycle I, out of 35 students, 15 students achieved completeness with a classical completeness percentage of 43% and a classical absorption rate of 69%. The average learning outcome was 69%. However, classical completeness had not yet reached the target of 75%, so the study continued to Cycle II. In Cycle II, learning outcomes increased significantly, with 33 students achieving completeness with a classical completeness percentage of 94% and a classical absorption rate of 83%.
3	Rika Dwi Wijayanti, Dian Karina Rachmawati, Dina Kamaliana. 2023	Penerapan Model Pembelajaran Discovery Learning Meningkatkan Hasil Belajar Mata Pelajaran Biologi Kelas 11 IPA. J-SES: Journal of Science, Education and Studies	Before the application of the discovery learning model, the calculated result of the students' learning improvement was 53.8 with a classical learning completeness percentage of 0% (not complete). After applying the discovery learning model, the calculated result of the students' learning improvement was 80.5 with a classical learning completeness percentage of 88.9% (complete).
4	Dian Abdjul. 2022	Penerapan Model Pembelajaran Discovery Learning Untuk Meningkatkan Hasil Belajar Biologi Pada Siswa Kelas X	The results of the study showed an improvement in Biology learning outcomes in each cycle. In Cycle I, the average student score was 79, increasing to 83 in Cycle II. The percentage of learning completeness also increased from 75% in Cycle I to 100% in Cycle II. These findings

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		SMA Negeri 1 Buntulia. AKSARA: Jurnal Ilmu Pendidikan Nonformal	indicate that the use of the Discovery Learning model is effective in improving student learning outcomes.
5	Adenirwati Gulo. 2022	Penerapan Model Discovery Learning Terhadap Hasil Belajar Peserta Didik Pada Materi Ekosistem. Educativo: Jurnal Pendidikan	The study was conducted through two cycles with the stages of planning, implementation, observation, and reflection. In the pre-cycle stage, challenges such as student inactivity were identified, and the pre-cycle exam results showed that most students had not reached the minimum completion criteria (KKM). However, after applying the Discovery Learning model in two cycles, there was a significant increase in student learning outcomes. In Cycle I, 37.14% of students achieved completeness, while in Cycle II, the percentage of students who achieved completeness increased to 87.5%.
6	I Dewa Putu Juwana and Ni Kadek Yuni Pradnyani. 2023	Penerapan Model Pembelajaran Discovery Learning Meningkatkan Hasil Belajar Biologi Siswa Materi Sistem Respirasi Kelas XI MIPA 2 SMA NEGERI 11 DENPASAR Tahun Pelajaran 2022/2023. Jurnal Pendidikan	The findings of this study showed that the implementation of the Discovery Learning Model improved the biology learning outcomes in the respiratory system material for Grade XI MIPA 2 students of SMA Negeri 11 Denpasar in the 2022/2023 academic year. There was an increase in the average student learning outcome in Cycle I from a pre-test average of 59 to a post-test score of 94.12. In Cycle II, the average pre-test score was 81.91, which increased to 97.35 in the post-test. These data indicate that the biology learning outcomes met the expectations of this study.
7	Iis Suminar Rahmi. 2019	Penerapan Model Discovery Learning Dengan Praktik “Anggit Angglang” Untuk Meningkatkan Hasil Belajar Siswa Pada Mata Pelajaran Biologi Di SMAN 2 Kota Tasikmalaya. Jurnal Pendidikan	The research results showed an increase in the average learning outcome score from 61.11 in meeting 1 of Cycle I to 66.94 in meeting 2 of Cycle I. Subsequently, the average learning outcome score improved from 75.69 in meeting 1 of Cycle II to 81.11 in meeting 2 of Cycle II. Meanwhile, the percentage of learning completeness increased from 15% in meeting 1 of Cycle I to 40% in meeting 2 of Cycle I. Then, in meeting 1 of Cycle II, the learning

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Bioedusiana	completeness percentage was 65%, which increased to 82.50% in meeting 2 of Cycle II. Based on these results, it can be concluded that the use of the Discovery Learning model with the 'Anggit Angglang' practice can improve the learning outcomes of Grade X Science 1 students of SMA Negeri 2 Kota Tasikmalaya in Biology.

Discovery learning is a series of learning activities that guide students to actively discover their own knowledge (Hanifah & Wasitohadi, 2017). This concept aligns with Siswanti and Wahyudi (2015), who argue that in discovery learning, students do not receive learning materials in their final form but are expected to organize the content themselves, focusing on discovering new concepts or principles. By utilizing this model, students become more curious and engaged in the learning process, actively participating through independent experiments or observations, which allows them to organize and deeply understand the material (Alfieri et al., 2011; Mayer, 2004).

Learning outcomes are the final evaluation of a continuous learning process, beginning from the introduction to the material and ending with its delivery (Bloom, 1956; Gagné, 1985). These outcomes encompass knowledge and skills retained in long-term memory and play a crucial role in character formation, influencing thought patterns and improving attitudes (Anderson et al., 2001; Krathwohl, 2002). To achieve the desired learning outcomes and provide a positive impact on both students and teachers, a well-planned and strategic approach is necessary (Gagné et al., 1992; Marzano, 2001). Learning outcomes should address all three domains in Bloom's Taxonomy: cognitive, affective, and psychomotor, which include remembering, understanding, applying, analyzing, evaluating, and creating (Anderson et al., 2001). Therefore, lesson planning by teachers must consider all these aspects to meet the intended educational goals (Biggs & Tang, 2011).

The results from the seven studies reviewed demonstrate that the application of the discovery learning model has a positive impact on improving student learning outcomes in high school biology. Discovery learning encourages students to actively engage in the learning process through activities such as experiments, observations, and problem-solving, leading to deeper comprehension and independent organization of information (Hmelo-Silver et al., 2007; Harlen & Qualter, 2018). This model fosters active participation and shifts the learning process from passive reception to active discovery, which contributes to enhanced academic performance (Zohar & Dori, 2003; Gormally et al., 2012).

All seven studies utilized experimental and classroom action research approaches to examine the effectiveness of the discovery learning model. In experimental studies, the discovery learning model was compared with other instructional models or control groups, with learning outcomes measured before and after the

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treatment (Alfieri et al., 2011; Schmidt et al., 2009). The results showed significant differences between the groups, with discovery learning consistently outperforming other models. In classroom action research, researchers implemented the discovery learning model across several cycles. Learning outcomes improved from one cycle to the next, underscoring the continuous effectiveness of the discovery learning model (Kirschner et al., 2006; Gijbels et al., 2005).

The findings from these studies provide strong support for the use of the discovery learning model in improving student learning outcomes in biology. This confirms that active involvement in the learning process, as emphasized in discovery learning, creates a more effective learning environment and leads to significant improvements in students' academic achievements (Chen et al., 2019; Dumont et al., 2010).

Studies 1, 3, 4, 5, 6, and 7 show that the application of the discovery learning model is effective in improving high school biology students' learning outcomes. Significant improvements in learning were observed after the application of the discovery learning model, as evidenced by post-test results showing significant increases in scores and mastery percentages (Suardana et al., 2017; Areepattamannil et al., 2015). Statistical analysis in several studies also indicated significant differences between the groups using discovery learning and the control groups, demonstrating that the model successfully enhanced students' understanding and mastery of biology concepts (Chen et al., 2019).

Study 2, initially, did not show the effectiveness of the discovery learning model in improving high school biology students' learning outcomes during Cycle I. However, after adjustments and improvements in implementation during Cycle II, significant improvements were observed (Prasetyo et al., 2020). This suggests that while discovery learning is generally effective, adjustments or refinements may be necessary in certain cases to achieve optimal results (Kirschner et al., 2006).

Overall, the results from the seven reviewed studies demonstrate that discovery learning effectively enhances students' understanding of complex biology concepts in high school (Gijbels et al., 2005; Schmidt et al., 2009). Several factors contribute to this success: First, discovery learning encourages active student participation through experiments, observations, and problem-solving activities, which deepens their understanding of complex biological concepts (Hmelo-Silver et al., 2007). Second, discovery learning fosters curiosity and interest in the subject matter, as students have the opportunity to explore and discover new concepts independently. This results in high intrinsic motivation, which in turn enhances student engagement and focus during the learning process (Alfieri et al., 2011).

Third, the discovery learning model allows students to learn in real-world or situational contexts, helping them to better understand complex biology concepts. By conducting experiments and engaging in direct analysis, students can connect theoretical concepts to practical applications, reinforcing their understanding (Mayer, 2004; Kolb & Kolb, 2005). Fourth, discovery learning encourages students to reflect on and

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analyze the results of their experiments or observations, helping them reorganize the information they have learned and internalize complex biology concepts (DeHaan, 2005). Lastly, the discovery learning model allows teachers to utilize various types of student intelligences, such as visual-spatial, verbal-linguistic, logical-mathematical, and bodily-kinesthetic. By integrating diverse learning approaches, discovery learning facilitates the understanding of complex biology material for a wide range of learners (Gardner, 1999).

IV. CONCLUSION

Based on the systematic literature review of seven articles examining the implementation of the Discovery Learning model in secondary school education, it can be concluded that this model is consistently effective in improving student learning outcomes. Discovery Learning not only helps students deepen their understanding of complex biology concepts through active experimentation and observation, but it also enhances their intrinsic motivation to learn. However, its implementation requires careful planning and strategies to address challenges such as extended learning time and differences in students' abilities to grasp concepts independently. Overall, Discovery Learning is a reliable instructional model for enhancing high school biology learning outcomes, provided that proper management and planning support are in place.

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