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The Influence of the guided discovery learning model on student learning outcomes in biology learning: A literature study

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Abstract. Students' learning outcomes in biology remain relatively low, primarily due to instructional methods that fail to actively engage learners. This gap is crucial, as current curricula emphasize student-centered learning and the development of 21st-century skills. One promising solution is the implementation of the Guided Discovery Learning (GDL) model, which encourages students to discover concepts independently with structured guidance while keeping them actively involved. This study aims to analyze the impact of GDL on student learning outcomes through a literature review. This study was conducted using a descriptive qualitative method through a literature review of national journal articles. Articles were obtained from google scholar using the keywords guided discovery learning model, student learning outcomes, and biology education. The data were analyzed using content analysis. The findings show that GDL-related publications peaked in twenty twenty-two. All selected studies found the GDL model effective in improving cognitive, affective, and psychomotor outcomes, as well as motivation, engagement, and critical thinking. Thus, GDL is recommended as an effective instructional model in biology education.

Abstrak. Hasil belajar siswa pada mata pelajaran biologi masih tergolong rendah, terutama disebabkan oleh metode pembelajaran yang kurang melibatkan siswa secara aktif. Kesenjangan ini menjadi masalah penting karena kurikulum merdeka menuntut pembelajaran yang berpusat pada siswa dan mampu mengembangkan keterampilan abad ke-21. Salah satu alternatif solusi yang ditawarkan adalah penerapan model pembelajaran Guided Discovery Learning (GDL). Model ini memberikan bimbingan kepada siswa dalam proses penemuan konsep, sehingga siswa tetap aktif namun tidak kehilangan arah. Tujuan penelitian ini adalah untuk menganalisis pengaruh model GDL terhadap hasil belajar siswa melalui studi literatur. Penelitian ini menggunakan metode kualitatif deskriptif dengan teknik telaah literatur terhadap artikel nasional. Artikel diperoleh dari database google scholar menggunakan kata kunci model pembelajaran guided discovey learning, hasil belajar siswa, dan pendidikan biologi. Data dianalisis menggunakan pendekatan analisis isi (content analysis). Hasil kajian menunjukkan bahwa publikasi terkait model GDL meningkat dalam lima tahun terakhir, dengan puncak pada tahun 2022. Dari 10 artikel yang dianalisis, seluruhnya menyatakan bahwa model ini efektif meningkatkan hasil belajar siswa, baik secara kognitif, afektif, maupun psikomotor. GDL juga terbukti meningkatkan motivasi, keaktifan, dan berpikir kritis siswa, sehingga relevan diterapkan untuk mengatasi rendahnya hasil belajar Biologi di sekolah. Dengan demikian, model GDL direkomendasikan sebagai model pembelajaran yang efektif dalam pembelajaran biologi.

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Introduction

In the contemporary globalised era, the field of education is confronted with a series of intricate challenges. The exponential growth of science and information technology has transformed almost every aspect of human life, significantly impacting the way humans live (Iswanti et al., 2025). Consequently, in this era of accelerated scientific and technological advancement, there is an imperative for highly skilled human resources who possess innovative and unique competencies. The 4C skills (critical thinking, communication, collaboration, and creativity) are essential aspects that students must have to address the complex educational challenges of the contemporary world and the development of education in Indonesia (Maulinda, 2024).

The reality on the ground demonstrates a discrepancy between the expectations and reality of the learning process. The quality and effectiveness of learning are still suboptimal. The utilisation of monotonous teaching models and methods in the educational milieu has been demonstrated to engender a state of ennui, which can result in diminished engagement during instructional sessions (Herawati et al., 2022). Furthermore, as posited by Judijanto et al. (2024), inadequate student engagement during learning sessions has been demonstrated to exert a direct influence on the attainment of suboptimal learning outcomes. This condition also weakens students' critical thinking skills, which should be the key to improving the quality of learning and academic outcomes (Kalengkongan et al., 2021) in (Mangelep et al., 2023).

It is suggested that educators can harness students' innate curiosity as a catalyst for cultivating their critical thinking abilities (Sarwanto et al., 2021). As elucidated by Facione (2011) in Khoiriyah and Nasution (2025), critical thinking skills encompass the capacity to pose pertinent inquiries, methodically analyse data, proactively investigate issues, meticulously construct cogent arguments, and judiciously derive conclusions. As posited by Masruroh et al. (2025), there is a demonstrable correlation between enhancements in student learning outcomes and the cultivation of critical thinking skills. This phenomenon can be attributed to the students' pre-existing cognitive frameworks, which facilitate their engagement and success in the learning process. Consequently, a pedagogical approach is required that can facilitate active student engagement and promote optimal cognitive skill development.

One potential solution to this issue is the implementation of a learning model that emphasises student thinking and exploration activities. One such model is Guided Discovery Learning (GDL). The relevance of this model is evidenced by its integration of a contextual problem-solving approach, which enables students to proactively engage in finding solutions to the problems they face (Lohonauman et al., 2023) in (Mangelep et al., 2023). Through this active involvement, students not only gain a deeper conceptual understanding but also develop a positive attitude toward learning and cultivate essential critical, creative, and collaborative thinking skills needed to tackle 21st-century learning challenges (Ramadhan & Hindun, 2023).

In this context, Mangelep et al. (2023) posit that GDL fosters an environment conducive to independent discovery of knowledge by students, albeit with structured guidance. This perspective aligns with constructivist theory, which posits that students actively contribute to the construction of their own knowledge Click or tap here to enter text. (Mangelep et al., 2023). This process has been shown to enhance long-term retention and cultivate critical thinking skills, which are vital for attaining optimal learning outcomes.

A plethora of studies have demonstrated the efficacy of the Guided Discovery Learning (GDL) model in enhancing student learning outcomes and cultivating critical thinking skills. Kristalia and Yerimadesi (2021) reported that GDL-based e-modules are effective in achieving high learning outcomes and improving student learning outcomes. Jannah (2024) research posits that guided discovery learning has proven effective in the learning process, with the potential to enhance student learning outcomes and critical thinking skills. Concurrently, Batubara (2020) research indicates that the enhancement in student learning outcomes through the GDL learning model is more pronounced than the improvement observed in learning outcomes among students who did not receive the intervention. The findings of this study indicate that this model focuses not only on mastering the material but also on developing scientific thinking abilities and problem-solving skills. However, there is still a paucity of research specifically examining the application of the GDL model in Biology at the high school level. Empirical studies on the influence of GDL on student learning outcomes in this context are still limited, so further research is needed to explore the effectiveness of this model in improving Biology learning outcomes more deeply.

In order to master 21st-century skills, it is necessary to apply effective learning models to improve learning outcomes and critical thinking skills. Guided Discovery Learning (GDL) is a relevant approach to use in this context. In accordance with the perspective advanced by Siti (2023), the implementation of the GDL model has the potential to foster a safe and conducive learning environment. This environment is conducive to active student learning, facilitating the discovery and engagement of students in the process of concept formation through exploratory activities and problem-solving. This, in turn, renders learning more meaningful and enables students to retain the material they have learned, thus aligning with effective and optimal learning. Despite the plethora of studies that have demonstrated the efficacy of GDL, research specifically examining its application in high school biology education remains scarce.

The objective of this literature review is to analyse information from previous studies on the influence of the GDL learning model on student learning outcomes in Biology. It is hoped that this review will provide a comprehensive and evidence-based overview of the effectiveness of this learning model in improving students' conceptual understanding and learning outcomes in Biology.

Research Methods

This study uses a Systematic Literature Review (SLR) research method, which utilizes secondary data obtained from various scientific works and current literature. Data was searched starting in July through the Google Scholar website within the time frame of 2020 to 2024 using the keywords “Guided Discovery Learning model, student learning outcomes, biology education.” Based on these keywords, 5,450 articles were identified, and 10 of the most relevant were selected. The selection of articles was determined using the procedure outlined in Figure 1. Data collection was conducted by gathering key information from each article based on research findings. Furthermore, data analysis in this study employed content analysis. This analysis was conducted by systematically reviewing the content of the collected articles or journals, then identifying the main themes, patterns of findings, and relationships between concepts relevant to the research focus. Through this approach, information from various literature sources was classified and interpreted to gain a comprehensive understanding of the influence of the Guided Discovery Learning (GDL) model on student learning outcomes in biology education.

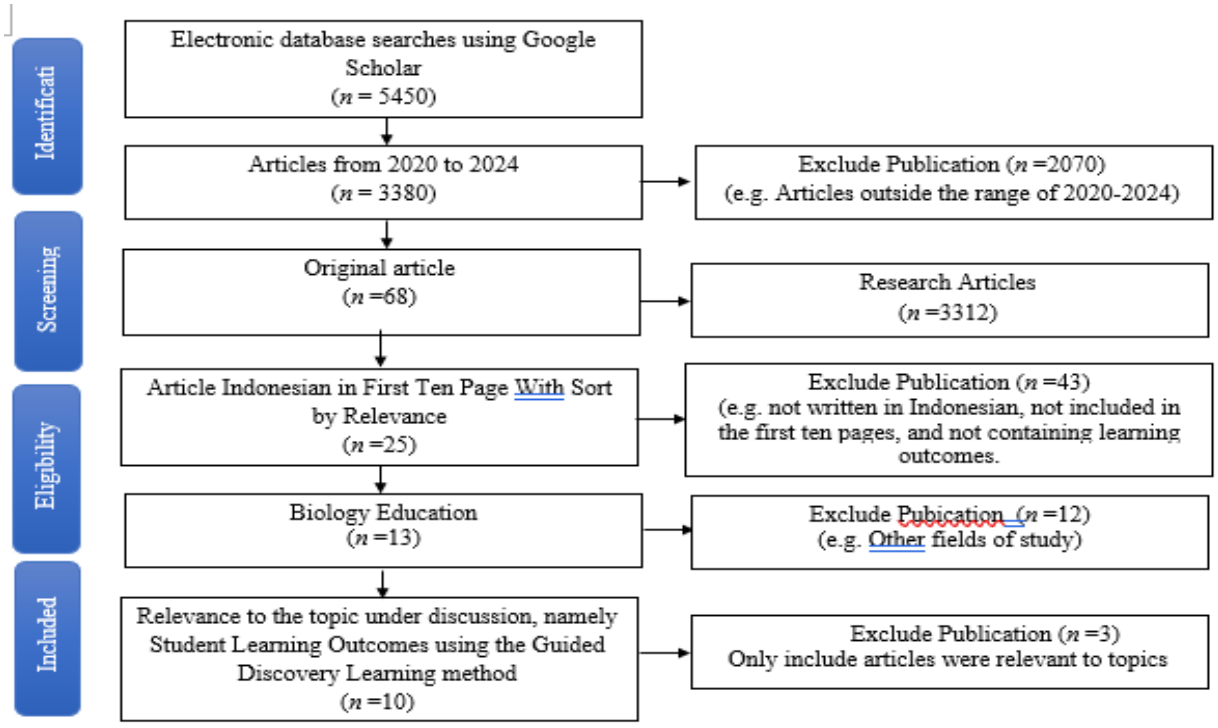

Figure 1 Articles selection procedure

Results and Discussion

This research trend can be observed through a graph showing the development of the number of studies using the Guided Discovery Learning (GDL) model in biology education over the past five years. The following graph illustrates the aforementioned research trend (see Figure 2). As illustrated in Figure 2, there has been a substantial surge in the utilization of the Guided Discovery Learning (GDL) model in biology education between 2020 and 2023. This observation is supported by a growing body of research investigating the efficacy of the Guided Discovery Learning (GDL) model as a substitute for conventional teaching methods, which are often perceived as lacking in engagement by students. However, this trend underwent a decline in 2024, potentially attributable to a shift in research focus toward alternative learning models or a paucity of publications re-evaluating the efficacy of Guided Discovery Learning (GDL) in that year. In order to maintain the currency and pertinence of research on GDL, there is a necessity for innovations in its

application, such as the integration of Guided Discovery Learning (GDL) with digital learning media, including virtual labs, interactive simulations, and e-mind mapping. Furthermore, research on Guided Discovery Learning (GDL) should be directed toward 21st-century learning contexts, such as the development of critical thinking, collaborative, and digital science literacy skills. Following the selection process, the ten most pertinent articles addressing this subject are enumerated in Table 1. A comprehensive literature review was conducted to identify ten articles that are most relevant to the research focus. The results of this review are presented in Table 1.

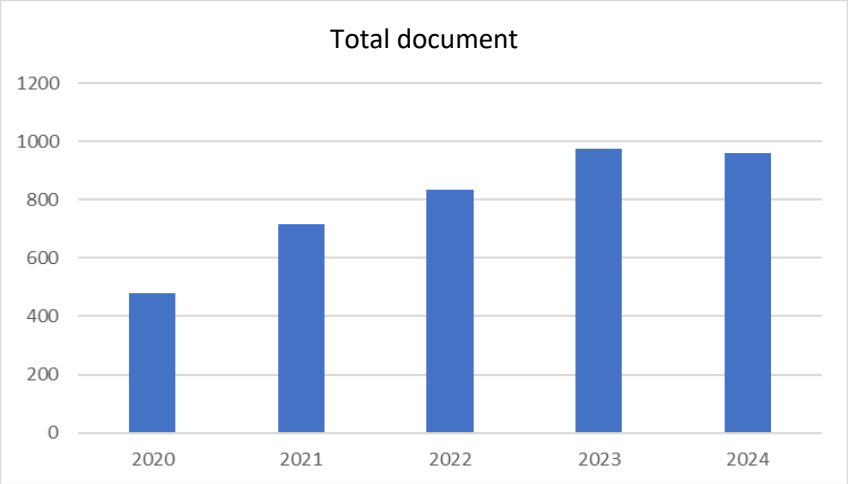

Figure 2 The following graph illustrates the number of research documents published in the last five years

Table 1 The Findings of Research Conducted on the Application of the Guided Discovery Learning Method

Code	Research (Year)	Problem	Method	Findings
A1	(Wijaya, 2022)	The e-module development has not employed the appropriate learning model. It is evident that educators have not yet incorporated a model that fosters active student engagement in the learning process.	The present study utilizes the ADDIE development model, which comprises five stages, in the context of research and development (R&D). The following five stages are to be considered: analysis, development, design, implementation, and evaluation.	The Guided Discovery Learning (GDL) biology e-module on the topic of ecosystems and the environment was found to be valid, practical, and effective. The validation of the study's findings was obtained through expert consultation, while practicality was assessed based on responses from teachers and students. The study demonstrated effectiveness in enhancing learning outcomes, with a p-value of 0.0001 and a classical completeness rate of 94%.
A2	(Haslinar et al., 2022)	The dearth of academic success among students, coupled with their anemic scientific attitudes, is attributable to the preeminence of conventional learning methodologies. These methodologies engender a passive student role, hindering their autonomy in conceptual discovery.	The present study employs a true experiment research design, utilizing a posttest-only control group design. The experimental class employed a Guided Discovery Learning (GDL) approach, while the control class followed a direct learning method. The data were collected through the administration of tests and questionnaires, and were subsequently analyzed by independent t-tests, following the validation of the underlying assumptions.	The Guided Discovery Learning (GDL) model demonstrated a marked enhancement in students' learning outcomes and scientific attitudes when compared with conventional learning methods. A significant proportion of experimental class students, specifically 86.67%, attained the "very good" category, indicating a substantial improvement in their scientific comprehension and disposition.
A3	(Mamesah et al., 2024)	The dearth of interest and the paucity of learning outcomes in the field of biology have been attributed to conventional pedagogical methods and the utilization of group divisions that eschew an active and contextual approach. Students have been observed to exhibit a proclivity for passivity, diminished involvement in	The present study employs a quasi-experimental research design, utilizing a pretest-posttest control group design. The experimental class employed the Guided Discovery Learning (GDL) model, while the control class utilized contextual learning. The data were collected through the administration of two	The Guided Discovery Learning (GDL) model had a significant effect on learning outcomes, as indicated by the average posttest score of the experimental class, which exceeded that of the control class. The t-test demonstrated that the observed t-value exceeded the critical t-value at a significance level of 0.05,

Code	Research (Year)	Problem	Method	Findings
		discussions, and a pronounced difficulty in comprehending abstract material. These tendencies have been posited to contribute to a suboptimal capacity for critical thinking.	instruments: a description test and a multiple-choice test (post-test). The collected data were then analyzed using the criteria of normality, homogeneity, and the t-test.	thereby indicating a statistically significant difference between the two groups.
A4	(Khoiriyah & Nasution, 2025)	The inquiry-based scientific process skills and learning outcomes of students in class X SMA Argopuro Panti Jember on the subject of biogeochemical cycles, which are caused by learning, are still centered on the teacher and do not involve students actively.	The present study employed a quantitative research design, utilizing a posttest-only control group design. The study's participants comprised two classes (control and experimental) with a total of 59 students. The assessment instruments employed included essay tests for science process skills and multiple-choice tests for cognitive learning outcomes. The collected data were then subjected to rigorous statistical analysis, employing both the Mann-Whitney U-test and the Independent Sample T-test to ensure the robustness of the findings.	A substantial discrepancy was observed between the experimental and control classes. The experimental class with GDL demonstrated a higher level of proficiency in science process skills (72.6) and learning outcomes (78) compared to the control class, which attained 61.7 and 67, respectively. This finding serves to corroborate the efficacy of *Guided Discovery Learning* (GDL) in enhancing students' engagement, science process skills, and learning outcomes.
A5	(Atiyah et al., 2020)	The conventional learning model has been identified as a contributing factor to the suboptimal student learning outcomes in the field of biology, particularly in the domain of the reproductive system. This issue is further compounded by the learning environment's lack of interactivity, which can lead to a perception among students that certain topics are considered taboo and therefore less engaging.	A comparative analysis is conducted between e-learning-based Guided Discovery Learning (GDL) and textbook-based GDL models. Additionally, the role of self-efficacy in shaping learning outcomes is measured. The instruments employed in this study consist of multiple-choice tests to assess learning outcomes and self-efficacy questionnaires. The collected data will be analyzed using two-way ANOVA and the Tukey test methods.	The findings indicated that the integration of e-learning with a Guided Discovery Learning (GDL) approach, coupled with high self-efficacy, yielded substantial enhancements in learning outcomes. The synergistic effect of these two factors engendered an environment that fostered student engagement, confidence, and the attainment of commendable results.
A6	(Ningsih et al., 2024)	The reduced level of interest and the suboptimal learning outcomes of biology students in respiratory system material can be attributed to the predominance of the lecture method, which engenders passive learning.	The quasi-experimental research design employed a nonequivalent control group design, and the study was conducted in two MIPA XI classes at MAN 1 Cirebon City. The experimental class employed the Guided Discovery Learning (GDL) model with the assistance of a mind map, while the control class utilized the conventional method. The data were collected through observation and pretest-posttest, and were analyzed by the N-gain test and paired sample t-test.	The experimental class exhibited an increase in teacher and student activities, as well as higher learning outcomes (75.63%; N-gain 0.62) compared to the control class (60.97%; N-gain 0.44). The efficacy of the GDL model, augmented by the utilization of a mind map, was substantiated through the implementation of a statistical test, which yielded a p-value of less than 0.05. This outcome is considered statistically significant at the 0.000 level.
A7	(Kusumayati, 2022)	The learning outcomes of students in class X IPA 2 SMA Negeri 7 Bogor City on Monera material are still low, with an average of 68.50 and only 44.44% reaching the KKM. The underlying causes of this phenomenon are multifaceted and include, but are not limited to, the utilization of ineffective pedagogical methods, the incorporation of abstract material, the absence of media resources, the presence of an unconducive learning environment, and a paucity of motivation to learn.	This research is a two-cycle PTK with an analytic descriptive method. Each cycle comprises four phases: planning, implementation, observation, and reflection. The Guided Discovery Learning (GDL) Model was implemented to motivate students to proactively explore concepts while receiving instruction from their teachers.	The learning outcomes demonstrated a marked increase from 75.83 (74.22%) in cycle I to 83.75 (94.44%) in cycle II. An increase in both student and teacher activities was observed, indicating that Guided Discovery Learning (GDL) is an effective pedagogical approach for enhancing comprehension and academic achievement in Monera material.
A8	(Putri, 2022)	A survey of students in class XI SMA Negeri 1 Jangka Buya reveals that 51.11% of students have not yet reached the KKM for respiratory system material. This is likely due to the fact that the current learning	This research is a two-cycle PTK (Action Research Project) with the stages of planning, implementation, observation, and reflection. The subjects were 35 students of class XI IPA 1 SMA Negeri 1 Jangka Buya. The	The Guided Discovery Learning (GDL) application has been demonstrated to enhance student activity from 65% to 80%, while concomitantly achieving student learning outcomes that meet the

Code	Research (Year)	Problem	Method	Findings
		model is one-directional and lacks interactivity. A more student-centered model is required.	data were collected through three primary means: observation, testing, and documentation. Following the collection of these data, they were analyzed through three distinct methods: descriptive, qualitative, and quantitative.	KKM. This pedagogical model has been shown to promote increased student activity, creativity, and motivation.
A9	(Widyawati, 2022)	The prevailing pedagogical approach employed in X MIPA 1 MAN 4 Sleman results in the passive comprehension of invertebrate material by students. The paucity of variety in methods and media has been demonstrated to have deleterious effects on learning outcomes and the development of independence.	The two-cycle PTK employs a Guided Discovery Learning (GDL) model assisted by LKS. The data obtained from the observation and post-test were subjected to qualitative and quantitative analysis.	The Guided Discovery Learning (GDL) model, augmented by LKS, exhibited a marked enhancement in learning outcomes, with a rise from 60% to 76.7%, and an average score increase from 64.3 to 75. The efficacy of the model in promoting active and independent learning was demonstrated by the enhancement of activities among teachers and students.
A10	(Alfia, 2023)	The dearth of scientific attitude and the subpar learning outcomes of students in class X at SMAN Pakusari Jember on the subject of Protista material can be attributed to the monotonous methods employed, the paucity of media resources, and the absence of student engagement. Consequently, numerous individuals have not attained the KKM, and their learning motivation is deficient.	The present study utilizes a quantitative research design, incorporating a quasi-experimental approach, characterized by the allocation of groups that are not equivalent at the posttest stage. The sample population for this study consists of two classes, each comprising 36 students. One of these classes is designated as the experimental group, while the other serves as the control group. The data were collected through the administration of a scientific attitude questionnaire and a posttest, and then analyzed using the Mann-Whitney test.	The mean scientific attitude and cognitive learning outcomes of experimental class students were higher than those of the control class. The Mann-Whitney test yielded a significance value of 0.000, indicating that the learning model effectively improved both.

Based on Table 1, it can be seen that the application of the Guided Discovery Learning (GDL) model in biology learning generally has a positive impact on various aspects of student learning outcomes. From the ten articles analyzed, it can be seen that Guided Discovery Learning (GDL) is not only able to improve students' cognitive outcomes but also strengthens scientific attitudes, scientific process skills, and encourages motivation and active participation during learning. This model encourages student activity through a structured discovery process, enabling them to build conceptual understanding independently yet still guided. Several studies also revealed that the application of Guided Discovery Learning (GDL) successfully increased the average posttest scores, the number of students who achieved the minimum competency standard, and involvement in classroom discussions. In addition, the combination of Guided Discovery Learning (GDL) with supporting media such as e-modules, mind maps, and worksheets has been proven to further increase its effectiveness, making learning more contextual, interesting, and meaningful for students.

Figure 3 illustrates the implementation of the Guided Discovery Learning (GDL), which encompasses a range of methodologies (R&D, True Experimental, Quasi Experimental, Quantitative Experiment, and PTK) and learning media (E-Module, Mind Map, LKPD, questionnaires and tests, and E-learning Platform). These elements are designed to enhance learning outcomes. The Guided Discovery Learning (GDL) model has been demonstrated to markedly enhance student learning outcomes and scientific attitudes in comparison to conventional learning methods. In a 2022 study, Haslinar et al. (2022) reported that 86.67% of students in the experimental class achieved the "very good" category. This finding aligns with the conclusions of Wijaya (2022) and Khoiriyah and Nasution (2025), which demonstrate that the consistent implementation of the Guided Discovery Learning (GDL) model enhances students' learning outcomes. This pedagogical model fosters an environment conducive to active and independent learning, wherein students are encouraged to engage in experiential learning, as opposed to a passive reception of instructional materials from the instructor (Wijaya, 2022). The effectiveness of GDL is further substantiated by the findings of Ningsih et al. (2024) and Widyawati (2022), who documented substantial increases in teacher activity (from 73.53% to 98.53%) and student activity (from 57.03% to 92.19%), along with discernible disparities in learning outcomes between the experimental and control groups (posttest scores of 75.63% vs. 60.97%) with N-gain values of 0.62 vs. 0.44. The efficacy of GDL, facilitated by mind maps, in enhancing student learning outcomes is substantiated by statistical tests (Sig. 0.000 < 0.05). Consequently, a comprehensive review of extant studies reveals that Guided Discovery Learning (GDL) is a pedagogical

model that not only enhances learning outcomes but also substantially fosters active engagement and scientific attitudes among students.

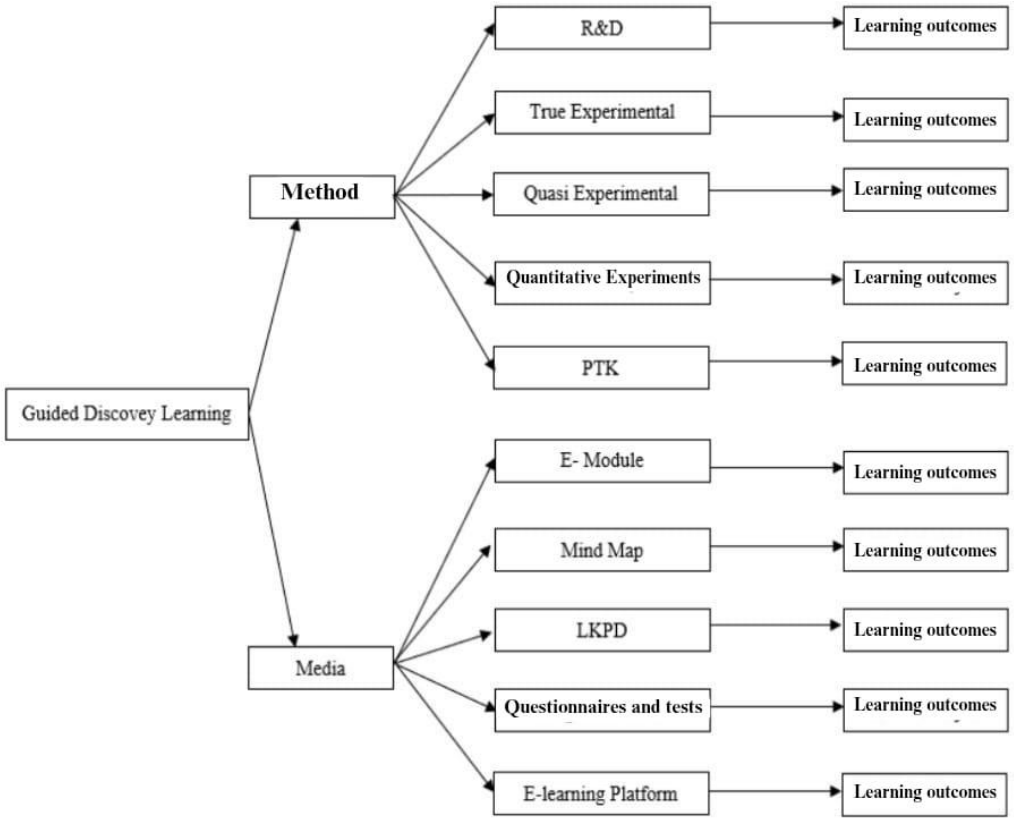

Figure 3 The following flowchart delineates the implementation of the Guided Discovery Learning Model

A multitude of studies have identified common issues in the realm of biology education, including suboptimal learning outcomes and a paucity of student engagement. These challenges are largely attributed to the preeminence of conventional teaching methodologies. Mamesah et al. (2024) posited that students often exhibit a passive stance and encounter challenges in comprehending abstract biology material, a phenomenon attributable to teaching methodologies that are characterized by inactivity and a lack of contextual relevance. Their findings indicate that the implementation of the Guided Discovery Learning (GDL) model significantly improves learning outcomes, as evidenced by higher posttest scores in the experimental class compared to the control class. Another study by Atiyah et al. (2020) compared e-learning-based Guided Discovery Learning (GDL) and textbooks. Their findings indicated that a combination of e-learning-based Guided Discovery Learning (GDL) and high self-efficacy resulted in a substantial enhancement in understanding of reproductive system material, along with increased student confidence and active participation. The findings of this study suggest that the incorporation of Guided Discovery Learning (GDL), particularly in conjunction with contextual methods and technology, not only fosters a more profound comprehension of complex concepts but also enhances students' sense of self-efficacy and promotes active engagement in biology learning.

Kusumayati (2022) also posited that the substandard achievement of the Minimum Passing Criteria (KKM) in Monera material was attributable to ineffective learning methods, overly abstract material, and inadequate learning motivation. The implementation of the Guided Discovery Learning (GDL) model in Classroom Action Research (PTK) resulted in a substantial enhancement in student learning outcomes from cycle to cycle. In Cycle I, the average class score increased to 75.83, with a mastery rate of 74.22%. In Cycle II, the mean score exhibited a subsequent increase to 83.75, accompanied by a mastery rate of 94.44%. An increase in both student and teacher activities was observed, suggesting that the Guided Discovery Learning (GDL) model is effective in enhancing student engagement, understanding, and learning outcomes in Monera material. The implementation of the Guided Discovery Learning (GDL) model has proven effective in overcoming learning challenges in abstract material, as well as in enhancing motivation, engagement, and sustained learning outcomes from one cycle to the next.

Conversely, teacher-centered learning has been shown to result in diminished student engagement, with 18 out of 35 students (51.11%) not meeting the minimum passing threshold. Following the implementation of the Guided Discovery Learning (GDL) model, there was an increase in student activity from 65% to 80%, concomitant with an

increase in the number of students who achieved the minimum passing grade (Putri, 2022). The dearth of diversity in pedagogical approaches and the paucity of student engagement contributed to the development of suboptimal scientific attitudes and cognitive learning outcomes among students exploring the Kingdom Protista. Utilizing an experimental design, the mean scientific attitude score of the experimental class attained 80, while the control class achieved 70. In terms of cognitive learning outcomes, the experimental class demonstrated an average of 85.56, while the control class exhibited an average of 78.31. The implementation of the Guided Discovery Learning (GDL) model was found to have a significant impact on the attitudes of students towards science and the cognitive learning outcomes of the students. This finding was supported by the Mann-Whitney test, which yielded a significance value of 0.000 (< 0.05). This result indicates that the Guided Discovery Learning (GDL) model is effective in improving both aspects of learning (Alfia, 2023). Consequently, the Guided Discovery Learning (GDL) model has been demonstrated to be efficacious in surmounting the constraints of conventional learning by fostering direct student engagement and substantially enhancing scientific attitudes and cognitive learning outcomes in biology material.

A comprehensive review of ten articles on the subject reveals the Guided Discovery Learning (GDL) model to be consistently effective in enhancing cognitive learning outcomes, fostering positive scientific attitudes, motivating students, and increasing their participation in biology learning. This pedagogical approach enables students to construct knowledge through active exploration and concept discovery, thereby enhancing their engagement and learning achievements. However, an examination of research trends pertaining to Guided Discovery Learning (GDL) reveals a decline in 2024, underscoring the necessity for innovation and updates in its implementation to maintain congruence with contemporary educational imperatives. Consequently, future endeavors should prioritize the integration of GDL with digital technology and 21st-century contextual approaches. Such integration may include the implementation of e-learning, virtual laboratories, interactive simulations, and other collaborative media.

Conclusion

A comprehensive review of ten research articles indicates that the Guided Discovery Learning (GDL) model exerts a favorable influence on student learning outcomes in the domain of biology. A substantial body of research has demonstrated the efficacy of GDL in enhancing student learning outcomes across the cognitive, affective, and psychomotor domains. A review of the extant literature reveals a consensus that the implementation of Guided Discovery Learning (GDL) has a significant impact on enhancing students' comprehension of scientific concepts, fostering positive attitudes towards science, promoting active learning, and developing their science process skills. This success has been observed in both face-to-face and technology-based learning modalities, including e-learning, as well as in instances where these learning modalities are combined with supporting media such as mind maps, student worksheets (LKS), or digital modules. The Guided Discovery Learning (GDL) model is predicated on the notion that students are guided to discover concepts through a structured active process. This process begins with problem posing, continues with independent exploration, and concludes with group discussion and drawing of conclusions. This pedagogical approach fosters not only memorization but also profound and constructive comprehension of concepts, thereby enabling students to construct their own knowledge. Consequently, future research endeavors may concentrate on the integration of Guided Discovery Learning (GDL) with digital learning media, such as virtual laboratories, interactive simulations, or e-mind mapping, to further advance the field. This step is expected to enhance the efficacy of the Guided Discovery Learning (GDL) model and address the challenges of 21st-century learning in a more comprehensive manner.

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