

Learning by discovery: the key to revolutionizing the teaching of biology in Colombia*

Aprendizaje por descubrimiento: la clave para revolucionar la enseñanza de la biología en Colombia



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Abstract

This bibliographic review article focuses on discovery learning as a key to revolutionizing the teaching of biology in Colombia. The central objective of the study is to exhaustively analyze how this methodology can improve scientific education in the country. To do this, different research and theories related to discovery learning and its application in the field of biology were reviewed. The theoretical findings highlight that it promotes critical thinking, creativity and motivation in students, which can potentially lead to greater interest and understanding of the area. In addition, it was found that it promotes autonomy and the development of cognitive skills in students. In conclusion, it is postulated that discovery learning could be an effective tool to improve the teaching of biology in Colombia, allowing students a greater understanding and appreciation of this scientific discipline.

Keywords: Discovery learning, revolution, teaching, biology, Colombia.

Resumen

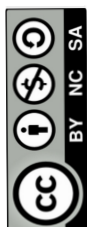
El presente artículo de revisión bibliográfica se enfoca en el aprendizaje por descubrimiento como clave para revolucionar la enseñanza de la biología en Colombia. El objetivo central del estudio es analizar de manera exhaustiva cómo esta metodología puede mejorar la educación científica en el país. Para ello, se revisaron diferentes investigaciones y teorías relacionadas con el aprendizaje por descubrimiento y su aplicación en el campo de la biología. Los hallazgos teóricos destacan que promueve el pensamiento crítico, la creatividad y la motivación de los estudiantes, lo que potencialmente puede llevar a un mayor interés y entendimiento del área. Además, se encontró que fomenta la autonomía y el desarrollo de habilidades cognitivas en los estudiantes. En conclusión, se postula que el aprendizaje por descubrimiento podría ser una herramienta efectiva para mejorar la enseñanza de la biología en Colombia, permitiendo a los estudiantes una mayor comprensión y apreciación de esta disciplina científica.

Palabras clave: Aprendizaje por descubrimiento, revolución, enseñanza, biología, Colombia.

Introduction

The teaching and learning process in the field of biology has been the subject of constant research and debate worldwide. In Colombia, the way this discipline is taught in schools and universities has been a concern for many educators due to the low levels of understanding and retention of content by students. In response to this scenario, discovery learning emerges as an innovative and effective alternative to revolutionize the teaching of biology in the country.

Discovery learning is a pedagogical approach based on the idea that students construct their own knowledge through exploration and experimentation. Instead of passively receiving information, students are encouraged to discover concepts and principles for themselves, allowing them to develop critical thinking, problem-solving, and teamwork skills. This approach is based



on constructivist theory, which holds that learning is an active and meaningful process built from the individual's interaction with their environment.

The central objective of this literature review article is to explore the different research and educational experiences that support the effectiveness of discovery learning in biology education, specifically in the Colombian context. It analyzes the benefits of this pedagogical approach in terms of student motivation and engagement, their ability to retain and apply acquired knowledge, and their development of cognitive and metacognitive skills. Additionally, it examines the strategies and resources that teachers can use to effectively implement discovery learning in the classroom.

In this context, the question arises: How can educators in Colombia adopt discovery learning as a pedagogical strategy to transform the teaching of biology and promote the holistic development of students? To answer this question, it is necessary to delve into the theory of discovery learning, as well as the experiences and studies that support its effectiveness in education. Moreover, it is important to consider the challenges and obstacles that may arise during the implementation of this approach and propose solutions to overcome them.

Throughout this article, various aspects related to discovery learning are addressed, from its theoretical foundation to its practical applications in the classroom. Studies demonstrating improvements in academic performance and student motivation exposed to this approach are reviewed, as well as strategies and techniques proven effective in fostering active and meaningful learning in the field of biology.

Furthermore, the implications of discovery learning for developing key 21st-century skills, such as problem-solving, decision-making, and effective communication, are analyzed. Possible adaptations and adjustments that educators need to make in their pedagogical practices to successfully integrate this approach into the biology curriculum, considering the particularities of the Colombian educational context, are also explored.

Thus, discovery learning is presented as a powerful tool to transform biology teaching in Colombia and improve the quality of education in the country. Through this approach, students not only acquire solid and lasting knowledge but also develop fundamental skills and competencies for their holistic formation and success in today's society. This article aims to provide a broad and updated perspective on discovery learning in the context of biology and inspire educators to rethink their pedagogical practices towards a more meaningful and transformative education.

Pedagogical Practice of Biology in Colombia

The pedagogical practice of biology in Colombia is a topic of great relevance today, as it is fundamental for the education of students in this field of knowledge. However, various problems affect the quality of biology teaching in the country, highlighting the need to improve the methodologies and pedagogical strategies employed in educational institutions.



First, it is important to note that the teaching of biology in Colombia faces several challenges, among which the lack of teacher training in this area of knowledge stands out. According to [Serrato \(2020\)](#), many of the teachers responsible for teaching biology classes in the country's schools and colleges do not have the necessary academic training to adequately address the content of this discipline. This is partly because, in many cases, teachers are assigned to this subject without having specific training in biology, which makes it difficult to convey knowledge clearly and precisely.

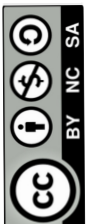
Additionally, it is worth highlighting that teaching is affected by the lack of adequate resources and didactic materials for class development. According to [Roa \(2020\)](#), educational institutions in the country do not have the necessary equipment to carry out laboratory practices or experimental activities in the classroom, limiting teachers' ability to teach biology concepts practically and dynamically. This results in theoretical and rote teaching that does not stimulate students' interest or participation in learning biology.

Another issue affecting the pedagogical practice of biology in Colombia is the lack of curricular content updates and the absence of a connection with the country's reality. According to [Moreno and Ussa \(2018\)](#), biology study plans in educational institutions do not align with Colombia's environmental and social needs and problems, making it difficult for students to understand the importance of biology in their daily context. Additionally, the lack of curricular content updates prevents teachers from teaching the most recent scientific and technological advances in the field of study.

Furthermore, it is important to note that the teaching of biology in Colombia is affected by students' lack of motivation and interest in this discipline. According to [Acevedo et al. \(2021\)](#), many students perceive biology as a boring and difficult-to-understand subject, which affects their low academic performance and lack of interest in learning more about this field of knowledge. This situation is exacerbated by the lack of innovative pedagogical strategies that could stimulate students' curiosity and motivation toward biology.

Given these problems, it is evident that improving the pedagogical practice of biology in Colombia is necessary to ensure comprehensive and quality education for students in this field of knowledge. To achieve this, it is essential to implement innovative pedagogical strategies that promote the meaningful learning of biology content, as well as the continuous training of teachers in this discipline. In this regard, authors like [Ausubel \(1968\)](#) have emphasized the importance of promoting meaningful learning among students by creating relationships between new knowledge and previously acquired knowledge. This implies that teachers should design activities that allow students to relate biology concepts to their daily lives so they can understand the relevance and applicability of this knowledge in their environment.

In this regard, [Vygotsky \(1978\)](#) has highlighted the importance of fostering collaborative learning in the classroom to stimulate students' active participation in constructing their knowledge. Therefore, teachers should promote teamwork and group activities that enhance cooperation and the exchange of ideas among students, thus fostering the development of social and cognitive skills in the field of biology.



Moreover, it is fundamental that teachers receive continuous and specialized training in this discipline to update their knowledge and strengthen their pedagogical skills. According to López (2023), teacher training is a determining factor in the quality of biology teaching, as a well-prepared teacher can clearly and effectively transmit the concepts and content of this discipline to their students. Hence, it is considered pertinent for educational institutions in Colombia to allocate more resources and support for the development of laboratory practices and experimental activities in the classroom to strengthen practical teaching. Experimental activities are essential for students to concretely understand theoretical biology concepts and stimulate their curiosity and interest in the discipline.

Similarly, it is necessary to review and update the biology curricular content in Colombia to ensure a connection with the country's environmental and social issues. Biology study plans should be periodically reviewed to include current and relevant topics that allow students to understand the importance of biology in environmental conservation, public health, and sustainable development. Regarding students' motivation towards biology, it is essential to implement innovative pedagogical strategies that stimulate their curiosity and interest in the discipline. Considering the contributions of Alcívar & Alcívar (2021), teachers can use technological resources such as videos, simulations, and interactive applications to make biology classes more attractive and promote active student learning. It is also important to encourage extracurricular activities such as field trips and scientific workshops, allowing students to explore and experiment with biology concepts practically.

In this context, the pedagogical practice of biology in Colombia faces various problems that affect the quality of teaching in this field of knowledge. To improve biology teaching in the country, it is essential to implement innovative pedagogical strategies that promote the meaningful learning of content, as well as the continuous training of teachers in this discipline. Promoting practical and experimental activities in the classroom, updating curricular content, and fostering students' motivation towards biology are crucial to ensuring comprehensive and quality education in this discipline. Only through a joint effort of educational institutions, teachers, and students will it be possible to improve the pedagogical practice of biology in Colombia and contribute to the development of excellent scientific education in the country.

Teacher Training in the Field of Biology

Teacher training in the field of biology in Colombia is a topic of utmost importance today, as it is an area of knowledge that is constantly evolving and requires updated and well-trained teachers to effectively convey scientific advances to their students. In this regard, it is essential that biology teachers stay abreast of new discoveries, teaching methodologies, and technologies applied to education.

In Colombia, teacher training in biology has seen significant progress in recent years, with the implementation of continuous training programs and the promotion of participation in conferences, symposia, and update sessions in the field. However, challenges remain that must be



overcome to achieve a true improvement in the quality of biology education in the country (Guevara *et al.*, 2022). One of the main challenges faced by teachers is the lack of resources and institutional support for professional development. Many teachers do not have the time or resources necessary to attend courses, training sessions, or academic events that would allow them to stay current in their discipline. Additionally, in some educational institutions, priority is given to training in areas considered more "priority," relegating biology training to a secondary position.

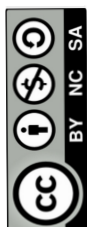
Another significant challenge is the lack of incentives for teacher professional development in the field of biology. Often, teachers do not receive recognition for their continuous effort to train, which demotivates their participation in update activities. Additionally, the lack of clear policies and professional development plans in the field of biology makes it difficult to plan and execute concrete actions to improve teacher training. It is crucial for educational authorities to implement concrete measures to promote teacher professional development in the field of biology. This can include creating continuous training programs, promoting scholarships and financial aid for attending academic events, including professional development as part of teacher performance evaluations, among other actions (Afanador, 2022).

It is important to highlight that teacher professional development in the field of biology benefits not only the teachers themselves but also their students. An updated teacher can more effectively convey knowledge to their students, fostering their interest in the discipline and promoting meaningful learning. Additionally, teacher professional development contributes to the overall improvement of educational quality, which positively impacts the country's development.

Regarding current trends in teacher professional development in the field of biology in Colombia, it is important to highlight the role of information and communication technologies (ICT) in teacher training. ICT offers very useful tools for professional development, such as virtual training platforms, online courses, digital educational resources, among others. The use of ICT in the training of biology teachers allows quick and easy access to updated information, facilitating continuous professional development in the discipline (Alcívar & Alcívar, 2021).

Another important trend in teacher professional development in the field of biology is the promotion of research and educational innovation. Teachers who participate in research projects in the field of biology have the opportunity to stay updated with the latest scientific advances and develop new teaching methodologies that favor student learning. Educational innovation in the teaching of biology is key to adapting to the changes and challenges of the 21st century and promoting meaningful learning in young people.

In this context, training biology teachers in digital competencies and active methodologies emerges as a fundamental aspect of professional development. Teachers must acquire skills in the use of digital tools, the creation of multimedia educational resources, and the design of interactive activities, among others, to enrich their pedagogical practice and improve the quality of biology education. It is relevant to consider collaboration between educational institutions,



government entities, academic organizations, and society in general. Creating support networks and spaces for exchanging experiences and best practices in the training of biology teachers can favor professional development and improve the quality of education in the country.

Nonetheless, it is essential to promote teacher autonomy and leadership in professional development (Valles *et al.*, 2015). Biology teachers must be the protagonists of their own training process, identifying their needs and seeking the necessary tools and resources for their professional development. Self-management of learning and continuous reflection on teaching practice are key aspects for the professional growth of teachers.

Transformation of the Pedagogical Process of Biology Through Discovery Learning

The teaching of biology has undergone a significant transformation in recent decades, shifting from a traditional focus on knowledge transmission to a more student-centered approach emphasizing active learning and discovery. This shift in the pedagogical process has been driven by advances in educational neuroscience and learning psychology, which have highlighted the importance of active student participation in their own learning process.

The discovery learning approach in biology education is based on the idea that students learn best when they are active participants in their learning process rather than passive recipients of information. This approach is grounded in constructivist learning theory, which posits that students construct their own knowledge from their prior experiences and interactions with their environment (Eleizalde *et al.*, 2010). According to the discovery learning approach, the role of the teacher is to facilitate learning rather than directly transmit knowledge. The teacher becomes a guide who provides students with the necessary tools to discover and construct their own knowledge through exploration and experimentation. This form of teaching promotes critical thinking, problem-solving, and teamwork, which are fundamental skills in the formation of a scientist.

One of the most important aspects of biology teaching based on discovery learning is the use of scientific research as a pedagogical tool. Arias and Oblitas (2014) state that students have the opportunity to conduct experiments, make observations, and analyze real data, allowing them to experience the scientific process firsthand and develop practical skills such as decision-making, critical analysis, and effective communication. Additionally, discovery learning fosters students' curiosity and interest in biology by allowing them to explore topics of interest and discover answers to their questions independently. This not only increases students' motivation towards learning but also helps them develop a deeper and more lasting understanding of biological concepts by connecting theory with practice and providing meaningful context.

However, despite its benefits, teaching biology through discovery learning also presents challenges for teachers, who must find a balance between guiding and allowing students freedom in their learning process. Moreover, some critics argue that this approach may be less time-efficient as it requires more resources and planning from teachers. Despite these challenges, the



trend towards a more discovery-centered approach in biology teaching is increasingly evident, as it has been shown to improve students' motivation, understanding, and engagement with the subject. Additionally, implementing this approach in the classroom has proven beneficial for student diversity, allowing each individual to learn at their own pace and style.

Therefore, according to [Castillo *et al.* \(2020\)](#), the transformation of the pedagogical process of biology through discovery learning has brought about a significant change in how this subject is taught, shifting from a traditional knowledge transmission approach to a more active learning and student participation-centered approach. This approach has proven beneficial in enhancing students' motivation, understanding, and engagement with biology, allowing them to explore, discover, and construct their own knowledge through experimentation and scientific research.

Conclusions

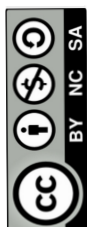
Discovery learning presents itself as an innovative educational strategy with the potential to revolutionize the teaching of biology in Colombia. Through the literature review conducted in this article, various studies have been identified that support the effectiveness of this methodology in fostering curiosity, intrinsic motivation, critical thinking, and deep understanding of biological concepts.

Discovery learning is based on constructivist theory, which posits that learning is an active process in which students construct their own knowledge through exploration, experimentation, and reflection. In the context of biology teaching, this methodology promotes the development of skills such as observation, inference, experimentation, and argumentation, which are fundamental for scientific thinking.

Throughout the literature review, it is observed that discovery learning has been successfully applied in different educational contexts, both at the school and university levels. In the school setting, research projects have been developed that involve students in formulating research questions, designing and conducting experiments, collecting and analyzing data, and presenting results. These experiences not only allow students to acquire conceptual knowledge but also to develop scientific skills and positive attitudes toward science.

In the educational context, these experiences have proven effective in promoting critical thinking, peer collaboration, autonomy, and responsibility in learning. Additionally, it has been shown that discovery learning can positively impact student motivation. By allowing them to explore and discover on their own, this methodology stimulates curiosity, interest, and intrinsic satisfaction with learning. Students become more active and engaged in their learning process, leading to better academic results and maintaining a positive attitude toward biology and science in general.

Regarding the understanding of biological concepts, it has been observed that discovery learning favors the construction of deeper and more meaningful knowledge. When faced with pro-



blematic and challenging situations, students are compelled to reflect, compare, integrate, and apply their prior knowledge to solve problems and make informed decisions. This type of active and contextualized learning allows students to fully understand the concepts rather than superficially memorizing disconnected information. It also promotes the development of transversal skills such as effective communication, teamwork, ethical decision-making, and adaptability to changing environments. These skills are essential for professional success and active participation in today's society, where biology plays a crucial role in understanding and solving health, environmental, and biodiversity problems.

In the Colombian context, the implementation of discovery learning in biology teaching presents a series of challenges and opportunities. On one hand, a paradigm shift is required in the way teaching and learning are conceived by both teachers and students. It is necessary to foster a culture of collaboration, exploration, and experimentation in the classroom, where mistakes are seen as learning opportunities and the diversity of ideas is valued. All of this requires institutional support and adequate resources for development. Teachers need to be trained in effective pedagogical strategies, provided with spaces and materials for experimentation and research, and continuously evaluated to improve educational practice.

In this regard, it is important to highlight the importance of formative assessment in discovery learning. Beyond traditional assessment based on exams and grades, it is crucial to implement evaluation strategies that allow monitoring student progress, identifying their strengths and weaknesses, and providing constructive feedback on their learning. Formative assessment promotes metacognition, which is the students' ability to reflect on their own learning and regulate their process autonomously.

In conclusion, discovery learning presents itself as a valuable tool to revolutionize the teaching of biology in Colombia. Through exploration, experimentation, and reflection, students can construct deep and meaningful knowledge of biological concepts, develop scientific and transversal skills, and maintain a positive and motivated attitude toward science. However, its implementation requires a paradigm shift, institutional support, and formative assessment to ensure its effectiveness and long-term sustainability.

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