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Pedagogical laboratories as teaching didactics in rural contexts

Laboratorios pedagógicos como didácticas docentes en contextos rurales

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ABSTRACT

Education in all countries is the key to the development of societies and human beings. Latin America and the Caribbean presents challenges to solve various issues that affect the quality of education. The rural school develops a set of strategies to promote the development of education for boys and girls. However, more efforts are still required on the part of educational institutions, teachers and the community in general. The article "Pedagogical laboratories as teaching didactics in rural contexts" identifies and describes these strategies as a contribution to the teaching-learning process in educational institutions, and the promotion of harmonious, collaborative and inclusive environments. It also explores the implementation of innovative teaching methods, which favor the development of pedagogical laboratories in teaching didactics in educational quality in rural contexts. The review is based on the collection and documentary analysis of didactic strategies applied in rural educational contexts, particularly those focused on pedagogical laboratories. The review shows that didactic strategies based on pedagogical laboratories contribute significantly to school coexistence within rural institutions. These didactics promote an inclusive, collaborative, respectful learning environment and integral development of students. It underlines the importance of adapting educational strategies to the specific needs of rural communities, offering key tools for education policy makers.

Keywords:
Education; Didactics; Pedagogical laboratories; Rural contexts; Teacher

RESUMEN

La educación en todos los países, es la clave para el desarrollo de las sociedades y de los seres humanos. Latinoamérica y el Caribe presenta desafíos para resolver diversos temas que afectan la calidad de la educación. La escuela rural desarrolla un conjunto de estrategias para fomentar el desarrollo de la educación para los niños y niñas. Sin embargo, aún se requiere más esfuerzos por parte de las instituciones educativas, de los docentes y de la comunidad en general. El artículo "Laboratorios pedagógicos como didácticas docentes en contextos rurales", identifica, describe estas estrategias como aporte a los proceso de enseñanza aprendizaje en las instituciones educativas, y la promoción de ambientes armónicos, colaborativos e inclusivos. Asimismo, explora la implementación de métodos de enseñanza innovadoras, que favorezcan el desarrollo de los laboratorios pedagógicos en las didácticas docentes en la calidad educativa en contextos rurales. La revisión se basa en la recopilación y análisis documentales sobre estrategias didácticas aplicadas en contextos educativos rurales, particularmente aquellas centradas en los laboratorios pedagógicos. La revisión demuestra que las estrategias didácticas basadas en laboratorios pedagógicos, aportan significativamente en la convivencia escolar dentro de las instituciones rurales. Estas didácticas fomentan un entorno de aprendizaje inclusivo, colaborativo, respetuoso y desarrollo integral de los estudiantes. Subraya la importancia de adaptar las estrategias educativas a las necesidades específicas de las comunidades rurales, ofreciendo herramientas clave para los responsables de las políticas educativas.

Palabras clave:
Educación; Didáctica; Laboratorios pedagógicos; Contextos rurales; Docente

INTRODUCTION

Education is essential for the integral development of human beings, not only by providing knowledge but also by fostering the skills, values, and tools necessary to face society's challenges. In rural contexts in Latin America and the Caribbean, especially in Colombia, educational institutions face various challenges, such as cultural diversity, access difficulties, poverty, and lack of resources. Despite these adversities, rural schools continue to play a crucial role in educating students and developing supportive school environments.

In this context , teaching strategies based on pedagogical laboratories have emerged as a key tool for improving teaching-learning rhythms in rural educational institutions. It is therefore important to review teaching methods using pedagogical laboratories in Colombian educational institutions in order to understand how these strategies contribute to creating more inclusive, respectful, and collaborative educational environments.

The main objective of this study is to review and analyze teaching strategies based on pedagogical laboratories and how they relate to rural Colombian educational institutions. It is important to note that the implementation of pedagogical laboratories as teaching strategies favors both the academic and overall development of students. To this end, various studies on this subject will be used as a methodology. This essay will be developed through an analysis of national policies and international contributions.

Likewise, it can be deduced that the implementation of pedagogical laboratories as teaching strategies plays a crucial role in students' academic and holistic development. In the context of Colombian rural education, these strategies contribute to improving both student learning and the overall educational environment. By addressing the theoretical foundations of pedagogical laboratories and exploring teachers' rationale for their implementation, it is evident that these practices not only enhance educational quality but also strengthen educators' commitment to creating more inclusive and effective learning spaces. In this sense, pedagogical laboratories are presented as an important educational opportunity for the transformation and improvement of education in rural contexts.

Colombian rural educational contexts

Education in rural Colombia represents significant challenges for the country's educational landscape. For Bautista Macía and González (2019), these contexts face structural problems that limit equitable access to quality education. From this perspective, teachers play a fundamental role, assuming commitments that go beyond traditional teaching, turning schools into key spaces for peacebuilding and community connection.

The 1991 Constitution and the 1994 General Education Law establish the regulatory framework that guarantees access to and quality of education, governed by the principles of the Ministry of National Education. The reality in rural areas is different. Serna and Patiño (2018) argue that the education system must adapt to the specific characteristics of communities to generate a positive impact on their quality of life and human development. This implies recognizing their cultural and social characteristics, allowing for contextualized and relevant education.

At this point, it is relevant to consider the perspective of González Fernández et al. (2023), who highlight the importance of a qualitative approach in educational research in these environments. During the pandemic, technological limitations and restricted access to learning resources exacerbated existing inequalities. The teaching experience in these conditions reflects the need for innovative and adaptive strategies that allow teaching-learning processes to be sustained despite the difficulties.

The scarce infrastructure and material resources are one of the main challenges limiting educational equity in rural areas. As Bautista Macía and González (2019) point out, the lack of differentiated policies creates an environment where teachers must fill structural gaps, making it difficult to implement traditional teaching methods. For Serna and Patiño (2018), the need for education that reflects the specific conditions of communities, ensuring its relevance and accessibility, is important.

Challenges in Rural Education in Colombia

Colombian rural education faces a series of difficult challenges that directly affect access to and the quality of learning in these communities. Despite efforts by the government, through the Ministry of National Education (MEN) and various organizations such as UNESCO and UNICEF, inequalities in infrastructure, resources, and teacher training remain minimal.

Likewise, UNESCO (2021) argues that rural education in Colombia is affected by socioeconomic factors, contexts of armed conflict, and the large wave of migration. It argues that many families depend on subsistence agricultural activities, which forces children to work instead of attending school. Likewise, in several regions, violence and forced displacement have generated interruptions in education, affecting the emotional and academic stability of students.

Similarly, access to education in rural Colombia faces multiple challenges, such as illiteracy, low schooling, and high non-attendance rates. Furthermore, the reality for children in these areas is that they often start school late and enter the workforce early. To achieve basic education completion in rural areas, it is necessary to implement strategies that consider the geographic, social, and cultural contexts of these communities. In these contexts, the Ministry of Education (MEN) has promoted Rural Education Projects (PER), which offer educational models adapted to the needs of the environment. Their main objective is to guarantee equitable access to education and recognize students' prior learning and background. To strengthen this initiative, the PER will be expanded through World Bank funding (MEN, 2008).

From the Colombian rural education sector, an approach has been promoted that prioritizes the integration of national technologies and content, without fully recognizing the practices and knowledge unique to rural, Indigenous, and Afro-descendant communities. This educational model often ignores the cultural dynamics and needs of rural students, which contributes to the persistent inequality in access to and quality of education. Furthermore, factors such as poverty, violence, and the lack of adequate infrastructure continue to represent significant obstacles to education in these territories. Therefore, despite government initiatives aimed at improving rural education, structural challenges still exist that limit inclusion and educational development in these communities (Arias, 2017).

In conclusion, the Colombian rural context presents significant educational challenges that require innovative and differentiated solutions. Although the regulatory framework guarantees the right to education, the reality of rural areas demands a contextualized approach that considers the specific conditions of each community. As Serna and Patiño (2018) affirm, adapting the education system to these needs is essential to promoting human and social development.

Pedagogical laboratories and teaching didactics in rural education

Education in rural Colombia faces various challenges due to the geographic, economic, and sociocultural conditions of the communities in which it is developed. In this context, teaching strategies must be designed to address the specific needs of students and their environments. One of the most innovative approaches is the use of teaching laboratories, which have proven to be a valuable tool for improving teaching and learning in these communities (MEN, 2020).

Over time, didactics has undergone significant evolution, moving from a rigorous method to a participatory, student-centered approach. Currently, pedagogical processes have integrated various technological tools to adapt to social and globalization demands. This perspective has allowed for improved knowledge acquisition in educational settings, highlighting the crucial role teachers play in implementing teaching methods, techniques, and strategies that facilitate learning (Zapata et al., 2024).

Didactic planning is an essential skill in teacher training because it allows for the planning and organization of the teaching and learning process, ensuring coherence in its constituent elements, such as objectives, content, and pedagogical strategies. Its nature is not static, but rather evolves based on the sociohistorical context and the teacher's experiences, becoming an anticipated representation of educational practice

(Monetti and Molina, 2023).

According to Salazar (2020), the pedagogical laboratories initiative implemented by the Colombian Ministry of National Education was created with the objective of promoting the exchange of educational experiences between teachers and principals of certified territorial entities. In this context, practices related to curricular flexibility during the COVID-19 emergency were compiled, addressing aspects such as learning prioritization, assessments adapted to the realities of institutions, and the connection of the educational community in pedagogical processes. Through work sessions, some needs in the provision of educational services were identified, and didactic and formative assessment strategies were promoted. As a result, the experiences shared by teachers were published on the Contacto Maestro platform, with the aim of inspiring other educators and strengthening education in the country.

Likewise, teaching strategies in rural education must be flexible and contextualized, responding to students' specific needs. Unlike urban education, where resources are often more accessible, in rural settings it is essential to leverage active methodologies that allow for greater student participation and understanding of knowledge. Furthermore, strategies such as project-based learning, collaborative learning, and an interdisciplinary approach have proven to be positive for developing academic and socio-emotional skills (Lemus and Guevara, 2021).

Similarly, the concept of pedagogical laboratories has emerged as an innovative alternative that seeks to transform traditional education by incorporating experimental and practical activities. These spaces allow students to explore academic concepts through experimentation, teamwork, and problem-based learning.

The main benefit of teaching labs is that they facilitate the integration of theoretical knowledge with practical application, contributing to the development of content and generating learning in students. Considering other aspects, they also promote the development of life skills, problem-solving, effective communication, and critical thinking, essential aspects for school coexistence and personal development (Herrera and Villafuerte, 2023).

At the same time, teaching labs not only serve an academic function but also influence the social dynamics within educational institutions. This fosters respectful interaction and collaboration among students, allowing them to develop key social skills for harmonious coexistence. Active participation in practical activities promotes respect for diversity of ideas and the peaceful resolution of conflicts.

According to recent studies, the implementation of educational laboratories has demonstrated a positive impact on students' motivation and interest in learning, as well as on reducing classroom conflicts. This is because students feel more engaged in their educational process by having the opportunity to experiment and construct knowledge independently (Lemus and Guevara, 2021).

An emerging strategy to address these challenges is the implementation of pedagogical laboratories. As a mechanism for inclusion, these spaces allow for the design of adaptive methodologies that align with the needs of rural students. As González et al. (2023) point out, these initiatives foster more equitable and participatory education, facilitating access to knowledge in an interactive and creative manner.

Therefore, it is argued that teaching strategies adapted to rural education and implemented in pedagogical laboratories represent an opportunity to improve the quality of education in rural contexts. These approaches not only improve academic learning but also strengthen the development of essential life skills and school coexistence. Through participatory and innovative methodological applications, it is possible to transform the educational experience in rural settings, providing students with the tools to face the challenges of the 21st century.

Pedagogical laboratories to transform teaching

In recent years, the advancement of digital technologies has transformed science teaching, providing new opportunities for active learning and experimentation. Pedagogical laboratories, both physical and virtual, play a crucial role in the

development of scientific competencies, allowing students to directly interact with phenomena that would otherwise be difficult to understand. As digital platforms have become more integrated into the educational environment, the implementation of simulations and virtual laboratories has emerged as an innovative pedagogical strategy. However, the effectiveness of these resources depends not only on their design and technological application, but also on the teaching methodologies adopted by teachers and the barriers students may face in terms of access and training. It is essential to understand how the theoretical foundations that support the use of laboratories contribute to meaningful learning and what challenges remain to achieve their effective integration in the classroom.

Therefore, the physical and environmental conditions of learning spaces, such as classrooms and teaching laboratories, play a central role in science teaching. While classrooms allow for the application of various teaching strategies, their predominant use can limit the development of experimental activities. In contrast, laboratories offer adequate resources for experimentation, highlighting the importance of combining both spaces to enrich learning (Cuaical and Cuesta, 2017).

Also, the integration of virtual laboratory simulators into science teaching offers new possibilities for pedagogical mediation, especially from a socio-historical perspective. As noted in Paula's (2017) studies, virtual laboratories allow students to interact with complex representations of scientific phenomena. This type of interaction is essential for facilitating the appropriation of scientific concepts and methods, fostering deeper and more contextualized learning. However, the effectiveness of these resources depends on the appropriate design of digital platforms and the way teachers implement them in the classroom. Paula argues that teacher guidance that contextualizes these resources within pedagogical strategies, such as inquiry-based teaching, is essential to maximize their potential. She emphasizes that not all students have equitable access to these technologies, which can create a gap in the quality of learning.

This is where the analysis by Espinoza et al. (2024) addresses the challenge of equitable access to education. In contexts where budget cuts affect the availability of adequate physical laboratories, virtual laboratories emerge as a valuable alternative. These resources allow students to access quality content and also contribute to the democratization of knowledge. According to the authors, open platforms and digital laboratories offer opportunities for more inclusive learning, although they acknowledge that their effective implementation requires overcoming barriers such as a lack of technological tools and insufficient teacher training. Furthermore, they mention that the regulation of commercial platforms can limit access to key information, which represents an additional challenge for their effective integration.

For their part, Canónico et al. (2024) emphasize the transformative impact of virtual laboratories in education. The integration of these laboratories has changed not only the way students experience scientific concepts but also how the learning process is approached. According to the authors, virtual laboratories allow students to develop skills interactively and safely, overcoming traditional limitations such as the lack of materials or the risks inherent in physical laboratories. This type of tool facilitates experimentation in controlled environments, which is particularly relevant for teaching disciplines such as physics, where the abstraction of concepts can be an obstacle to their understanding. However, they warn that the implementation of these resources faces challenges, such as limited access to technology and the need for adequate teacher training. These challenges can limit the reach of virtual laboratories if appropriate measures are not taken to ensure effective integration.

Since technological advances, the traditional teaching model in science laboratories remains predominant. Becerra and Silva (2024) criticize this model for focusing on the application of standardized procedures with predictable results, which limits students' ability to develop critical thinking skills. This traditional approach restricts students' creativity and ability to formulate hypotheses and experiment autonomously. In contrast, the authors propose a problematized approach in physics and chemistry laboratories, where students not only follow predefined

instructions but also have the opportunity to design experiments, formulate questions, and critically analyze results. This type of approach, closer to real scientific methodology, promotes more meaningful and active learning, allowing students to acquire skills in problem-solving and analytical thinking.

The impact of virtual laboratories also extends to the field of experimental sciences, where students can experiment in a flexible and safe manner, overcoming many of the limitations of traditional laboratories.

Along these lines, Campos and Benarroch (2024) highlight the effectiveness of virtual laboratories, particularly in physics teaching, where many students often face difficulties due to the abstraction of concepts. These laboratories let students to visualize scientific phenomena that would not be easy to replicate in a traditional laboratory. However, the authors also acknowledge that the impact of virtual laboratories can vary depending on the context and discipline. Combining hands-on experiences in physical and virtual environments can be an effective solution, as it provides a more complete understanding of the phenomena and reinforces the learning acquired in digital environments.

Finally, the flipped classroom has proven to be an effective strategy for teaching experimental sciences. Rico and Quintana (2024) point out that the model permits students to actively manage their learning by moving theoretical instruction outside the classroom and dedicating face-to-face time to experimentation and resolving questions. This strategy promotes student autonomy and encourages participation in the learning process. The results of implementing this model reflect an increase in student satisfaction and an improvement in their academic performance. However, the effectiveness of this approach depends on students' commitment to prior preparation, such as watching videos or reading materials, since a lack of preparation can limit the benefits of the flipped model.

Concerning the above mentioned, it can be seen that educational laboratories, both physical and virtual, are essential tools for the excellent development of scientific competencies and active student learning. The integration of simulations, virtual laboratories, and innovative pedagogical methodologies, such as the flipped classroom, has proven to be an important alternative to the traditional challenges of science teaching. It is important to note that these work possibilities require quality resources, teacher training, and access to technological tools. It is essential that educational systems invest in technological tools and in ongoing teacher training to ensure these resources are used effectively and that students have access to inclusive and meaningful learning opportunities. Likewise, virtual laboratories must be integrated with practical experiences in physical environments to strengthen meaningful learning of scientific phenomena. As we move toward more digitalized education, it is important to continue exploring and refining these pedagogical models to strengthen equitable and viable education for all students regardless of their background.

Teaching Role in the Implementation of Laboratories as Teaching Strategies

Teacher motivation is fundamental to developing teaching strategies that foster learning and emphasize classroom interaction. Teachers are not only responsible for transmitting knowledge but also for managing the emotional and social climate of the classroom. As Morin and Delgado (2017) point out, educators must be able to identify students' emotional needs, creating spaces that promote positive interactions and where students feel supported.

Teachers, as facilitators of learning, can incorporate various techniques and strategies into the classroom to improve their way of interacting, such as school mediation, which helps resolve conflicts and promote peace (Bondia, 2019). However, teachers must be prepared to integrate emotional education into their teaching practice, in order to strengthen the development of socioemotional competencies that contribute to effective school coexistence.

Similarly, according to Viloria (2022), learning strategies play an essential role in students' academic performance, especially in complex areas. Strategies facilitate the assimilation of knowledge, and contribute to improving the understanding and application of content, allowing

students to develop skills that positively impact their academic and professional development.

The use of didactic strategies in education is also important because they improve teaching-learning processes, facilitate the organization of content, encourage active student participation, and enhance the use of technological tools. These strategies not only improve educational quality but also promote meaningful learning adapted to the needs of the current school context (Carrillo, 2021).

Similarly, the use of laboratory practices as a teaching strategy strengthens science teaching, especially in the construction of academic scientific knowledge from a constructivist perspective, through experimentation. Students develop investigative and manipulative skills that allow them to strengthen their scientific competencies. Teachers play an important role in this process, selecting strategies that integrate theory and practice to facilitate the understanding of complex concepts, such as chemical reactions. The application of practices with different levels of openness allows students to move from guided execution to a more autonomous one, promoting their capacity for analysis, hypothesis formulation, and decision-making in the laboratory (Espinosa et al., 2016).

Equally, teachers play an essential role in the application of teaching strategies within educational laboratories, which significantly impacts student learning. However, the lack of pedagogical training among education professionals limits the effectiveness of these strategies. Using qualitative and quantitative methods, it has been observed that teachers possess great skill in their areas of knowledge, but some exhibit deficiencies in the use of teaching strategies in the classroom. This suggests the need for pedagogical training to optimize their teaching performance and improve the teaching-learning process in simulated academic environments (Hernández et al., 2015).

Correspondingly, in the study by Salinas and Garrido (2022), they analyze how innovation in pedagogical settings impacts teacher training through pedagogical laboratories. Over the course of an academic year, innovative teaching experiences were explored, highlighting how university professors reconfigure their professional identity through processes of methodological transformation, knowledge integration, and the incorporation of emotionality into learning. The research, with a qualitative approach, used records of interdisciplinary dialogues, written reflections, and focus groups to analyze teachers' perceptions of these experiences. The findings highlight the need for less structured and more flexible teaching, where creativity, questioning, and interaction between theory and practice are encouraged. In this sense, the classroom is conceived as a dynamic setting in which teachers, through innovative methodologies, generate meaningful learning spaces that transcend the simple transmission of knowledge.

CONCLUSIONS

The review and analysis of teaching strategies based on pedagogical laboratories in rural Colombian educational institutions have demonstrated their positive impact on improving the teaching-learning process. These strategies not only develop students' academic progress but also contribute to the creation of harmonious, collaborative, and inclusive environments within the school community, especially in rural settings.

First, it is highlighted that the use of pedagogical laboratories fosters dynamic and participatory teaching, allowing students to actively engage in their own learning. These strategies promote the development of critical thinking, conflict resolution, and experience-based learning, essential aspects of quality education in rural Colombian contexts. By focusing on experimentation and the practical application of knowledge, pedagogical laboratories offer an innovative alternative that reinforces student motivation and improves retention of academic content.

Furthermore, the implementation of these strategies proves to be an effective tool for developing inclusion and educational equity. In rural settings, where access to educational resources and technology is often limited, pedagogical labs provide equitable participation opportunities for all students, regardless of their socioeconomic status. They also foster cooperation

among students, allowing them to work as a team, share knowledge, and strengthen their social skills, which contributes to improving school coexistence and mutual respect within the classroom.

Another fundamental aspect is teacher participation in the implementation of teaching labs. Educator training and preparation are essential to ensuring the success of these strategies. The authors' testimonies collected in the review reflect that teachers who adopt innovative methodologies within teaching labs manage to generate motivation and academic performance in their students. In this sense, it is essential to continue promoting teacher training programs that allow them to acquire the tools and knowledge to effectively implement these strategies in the classroom.

Likewise, the implementation of effective pedagogical practices, such as teaching strategies based on pedagogical laboratories, has proven to be fundamental for improving the teaching-learning process in rural educational institutions. These practices favor the creation of inclusive and collaborative environments that, in turn, foster mutual respect and social relationships among members of the educational community. By adapting strategies to the identified needs of rural communities, not only is learning more effective, but also a holistic process for students that translates into a harmonious and respectful environment. The implementation of innovative teaching methods within pedagogical laboratories contributes to the quality of education in these contexts, making teaching more dynamic and participatory. Furthermore, the review emphasizes the importance of integrating practical experiences of teachers and students to assess the effectiveness of these strategies. The testimonies collected offer a real perspective on how pedagogical laboratories have positively impacted school coexistence and the academic development of students in rural areas. This highlights the importance of continuing to promote these innovative methodologies in educational policies, providing teachers with key tools to implement effective teaching practices that respond to the needs and challenges of rural areas.

Moreover, it is essential that educational policies recognize the importance of pedagogical laboratories as a strategy for improving education in rural areas. Investment in infrastructure, materials, and teacher training should be encouraged to ensure the sustainability and expansion of these practices. At the same time, practical experiences and testimonies from teachers and students should be incorporated into the formulation of educational policies to enable the design of strategies more tailored to the realities and needs of each rural context.

Furthermore, the importance of teaching labs in rural settings represents a key tool for enhancing learning in these contexts, where infrastructure and technology limitations can impact educational quality. These strategies allow students to acquire knowledge in a practical way, fostering deeper and more meaningful understanding. Respectively, their implementation contributes to closing educational gaps by offering innovative methodologies that help improve student motivation and performance.

In these contexts, teaching based on experimentation and problem-solving helps students develop critical and creative skills, which are essential for addressing the challenges of rural environments. Furthermore, teaching labs facilitate the adaptation of content to the reality of rural communities, promoting contextualized and relevant education.

Finally, the contributions of teaching labs to teaching practices offer significant benefits by providing innovative tools that enrich teaching methodology. The implementation of these strategies lets teachers to diversify their teaching techniques, incorporating elements of experimentation and active learning that stimulate student participation. Likewise, the use of teaching labs fosters the professional development of educators, as they require ongoing training for their effective implementation. Through training in these methodologies, teachers can improve their teaching skills, strengthening their ability to guide students in meaningful and collaborative learning processes.

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