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Teaching experiences for science learning: a systematic review

Experiencias docentes para los aprendizajes de ciencias: una revisión sistemática

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Abstract

Teaching experiences are essential for science learning, especially when they integrate approaches that connect scientific knowledge with social, cultural, and human dimensions. The main objective of this study was to analyze these experiences in the context of science teaching. To this end, a systematic review was conducted following the PRISMA methodology, establishing inclusion criteria based on keywords in English ("teaching experiences" AND "science learning"), selecting open-access articles from high-impact databases such as Scopus and Scielo, published between 2020 and 2025. Paid articles and book chapters were excluded. After the filtering process, 14 articles were selected from Scopus and 7 from Scielo, totaling 21 research articles analyzed. The results show that teaching experiences gain greater relevance when they incorporate innovative methodological approaches, such as Project-Based Learning, which has proven to be especially effective in science teaching. Furthermore, contextual, pedagogical, and technological factors directly influence the quality of these experiences. Supervision, accumulated experience, and a favorable institutional environment enhance the development of pedagogical skills. Finally, it is highlighted that the integration of active methodologies and technological tools—such as artificial intelligence, the flipped classroom, whiteboard animations, educational modules, and platforms like Socrative—encourages immediate and varied feedback, contributing significantly to strengthening scientific learning.

Keywords: teaching experiences, science learning, strategies.

Resumen

Las experiencias docentes resultan esenciales para el aprendizaje de las ciencias, especialmente cuando se integran enfoques que conectan el conocimiento científico con dimensiones sociales, culturales y humanas. El objetivo principal de este estudio fue analizar dichas experiencias en el contexto de la enseñanza de las ciencias. Para ello, se realizó una revisión sistemática siguiendo la metodología PRISMA, estableciendo criterios de inclusión basados en palabras clave en inglés ("*teaching experiences*" *AND* "*science learning*"), seleccionando artículos de acceso abierto en bases de datos de alto impacto como Scopus y Scielo, publicados entre 2020 y 2025. Se excluyeron artículos de pago y capítulos de libros. Tras el proceso de filtrado, se seleccionaron 14 artículos de Scopus y 7 de Scielo, sumando un total de 21 investigaciones analizadas. Los resultados evidencian que las experiencias docentes adquieren mayor relevancia cuando incorporan enfoques metodológicos innovadores, como el Aprendizaje Basado en Proyectos, que ha demostrado ser especialmente efectivo en la enseñanza de ciencias. Además, factores contextuales, pedagógicos y tecnológicos influyen directamente en la calidad de estas experiencias. La supervisión, la experiencia acumulada y un entorno institucional favorable potencian el desarrollo de competencias pedagógicas. Por último, se destaca que la integración de metodologías activas y herramientas tecnológicas —como la inteligencia artificial, el aula invertida, animaciones en pizarra, módulos educativos y plataformas como Socrative— favorece la retroalimentación inmediata y variada, contribuyendo de manera significativa al fortalecimiento del aprendizaje científico.

Palabras clave: experiencias docentes, aprendizajes de ciencias, estrategias.

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Introduction

Teaching experiences related to science learning, particularly among Jordanian educators, reflect a positive level of knowledge and a favorable perception of the STEM approach in teaching. However, challenges persist regarding its effective implementation in the classroom. Factors such as gender and teaching experience significantly influence these perceptions, highlighting the need to strengthen strategies that promote equitable and sustained adoption of the STEM approach, especially among those with less experience or working in less developed institutional contexts (Alsalhi et al., 2022).

On the other hand, there is a marked reliance on traditional assessment techniques, with written tests being the most utilized resource. Although more experienced tutors (with 5 to 10 years of experience) tend to diversify their methods, a cognitive approach centered on written evaluations still predominates. Furthermore, a direct relationship was identified between the preparation of assessments and their implementation, underscoring the urgency of enhancing tutors' competencies in designing more varied and formative assessment instruments (Darmawan et al., 2020).

Regarding agricultural practices, while techniques such as permanent ground cover, crop rotation, and direct seeding have proven effective in reducing CO_2 emissions in dry soils, their application in forage production across different regions has yet to be comprehensively evaluated. This limitation restricts understanding of their real impact on productivity and the mitigation of greenhouse gases within sustainable livestock systems (Mattos et al., 2024).

In the Latin American context, it is observed that the middle class tends to hold residents accountable for urban violence, reinforcing stereotypes of danger and disorder that directly affect educational contexts. These trends highlight the existence of school-related factors that impact teaching-learning processes (Haynes, 2024). Therefore, it is essential to strengthen peer interaction and collaboration, indicating that there remains room for improvement in the social dimension of science learning (Duque et al., 2023).

Within this framework, the scientific question was formulated: What are the teaching experiences related to science learning? The objective of the study was to analyze these experiences, delving into the factors that condition them and the opportunities for improvement in educational environments.

Methodology

The methodology was based on a systematic review that followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol. To this end, precise inclusion criteria were defined, using the English keywords "teaching experiences" AND "science learning." Open-access articles published between 2020 and 2025 were considered, sourced from high-impact databases such as Scopus and Scielo. Exclusion criteria were applied to omit articles requiring payment and book chapters.

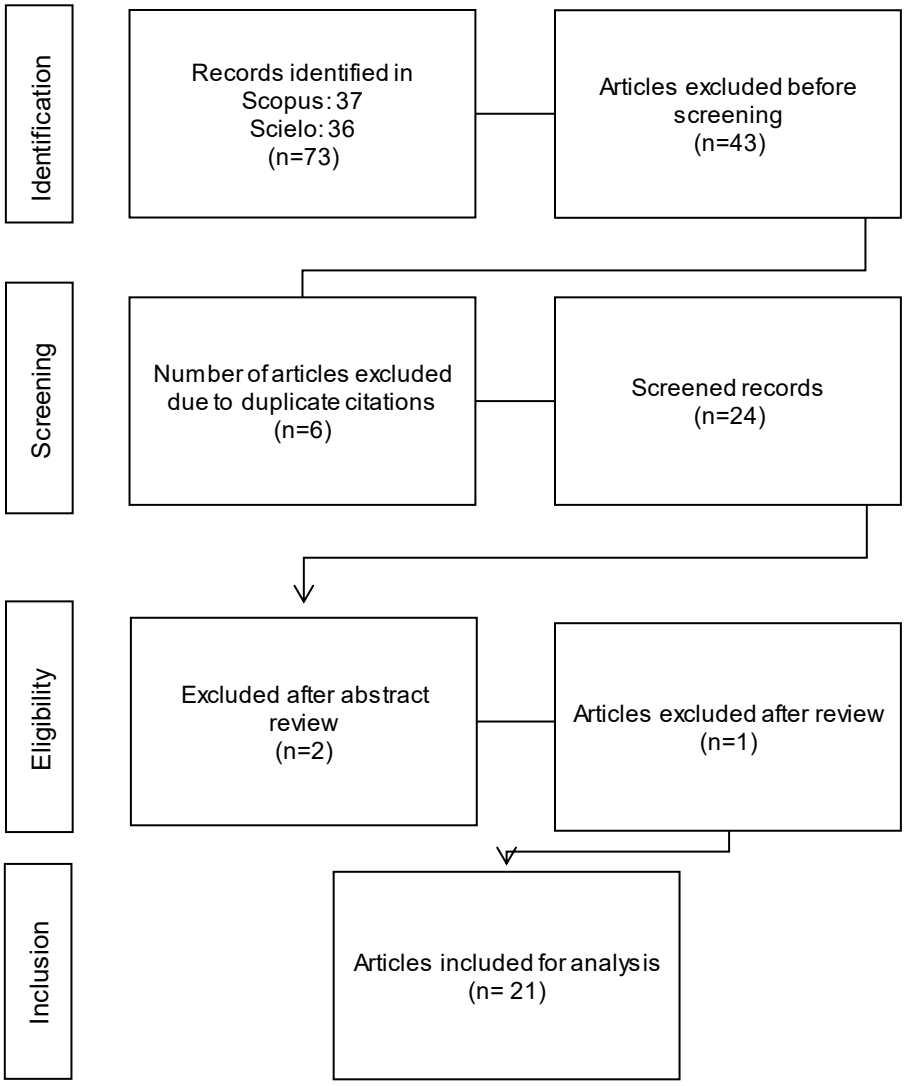
For result analysis, an initial filtering yielded 37 articles from Scopus and 36 from Scielo. Following a rigorous selection process, 14 articles from Scopus and 7 from Scielo were included, resulting in a total of 21 articles for the final analysis.

Table 1

Search keywords in database articles

Database	Search term	Results	Selected
Scopus	“teaching experiences” AND “science learning”	37	14
Scielo	“teaching experiences” AND “science learning”	36	7
	Total	**73**	**21**

Figure 1
PRISMA flow diagram



Note. Table formatted according to PRISMA with original data

Results

Table 2
Implications of teaching experiences for science learning

No.	Author	Implications of teaching experiences for science learning
1	Alali et al. (2025)	There is an urgent need to improve the application of formative assessment in primary science education, as its current use does not meet the expected minimum quality standards to enhance learning.

2	Suwardika et al. (2024)	The use of flipped classrooms with animations on whiteboards and educational modules has proven to be an effective strategy for enhancing self-regulation, critical thinking, and communication among pre-service and in-service teachers. This approach is particularly relevant in the context of digital education driven by Industry 4.0, as it allows for adapting web tutorials to new educational demands.
3	Septiyanto et al. (2024)	Teaching experience appears to have a greater influence on the understanding and mastery of scientific content than prior academic training. This underscores the need to promote continuous learning and professional development as a key strategy for strengthening teachers' competencies in science education.
4	Turnadi et al. (2023)	The development of teaching skills in science education is significantly influenced by factors such as clinical supervision, teacher experience, and the school organizational climate. The combined interaction of these elements demonstrates a positive impact on strengthening teaching competencies, reinforcing the need to consider these variables in the design of continuous training and professional support strategies.
5	Indriyanti & Sari (2023)	The application of the STEM approach in science teaching is valued as essential by most in-service teachers, although challenges in its effective implementation persist. Limited understanding and practical experience, especially among less experienced teachers, highlight the need for systematic and sustained support to strengthen their pedagogical competencies.
6	Lammert et al. (2023)	Prolonged professional development can transform the epistemic orientations of early childhood educators, promoting knowledge-centered approaches to science teaching. However, this change does not occur uniformly, indicating the necessity for differentiated and sustained training strategies.
7	Chen et al. (2023)	Pedagogical beliefs directly influence how teachers integrate digital resources into science education. While some adopt active methodologies that promote student autonomy, others maintain traditional approaches that limit the use of technological tools. This highlights the need to design training strategies that account for these differences to achieve effective e-learning implementation in primary education.
8	Tierno et al. (2022)	Inquiry-based approaches are valued as a key methodology by teacher trainers in science in Spain, integrating scientific and didactic content focused on active methodologies, prior knowledge, and common learning difficulties. This trend suggests that initial training favors didactic strategies that promote critical thinking and deep understanding of science through practice.
9	Fraile et al. (2021)	The use of digital tools like Socrative in teacher training contexts promotes self-regulated learning through immediate, varied, and progressive feedback. This strategy fosters greater student engagement and strengthens their autonomy when facing tasks of varying difficulty levels. Therefore, it is recognized as an effective pedagogical resource for organizing activities that integrate formative assessment and peer collaboration.
10	You et al. (2021)	Socioeconomic status, school climate, and type of institution directly affect performance in scientific literacy, while factors such as school size, teaching experience, or participation in professional training do not show significant impact. This evidence allows for reevaluating which school conditions favor science learning,

		highlighting that not all traditionally valued elements in schools guarantee better outcomes.
11	Riggs & Lee (2022)	The use of pedagogical approaches such as garden-based learning (GBL) promotes meaningful experiences that strengthen students' perceptions of competence, belonging, and autonomy in science. By integrating practical and authentic activities in outdoor spaces, emotional and cognitive connections are fostered, enhancing participation, interest, and connection to the environment.
12	Leonardo & Cha (2021)	The design of teacher training spaces based on the principles of Universal Design for Learning (UDL) helped strengthen the self-efficacy of science teachers in facing the challenges of teaching during the pandemic. This training strategy, implemented through virtual seminars, proved effective regardless of gender or prior experience, suggesting its potential applicability in future professional development programs.
13	Ryane & El Faddouli (2020)	Integrating resources aligned with the nature of science, such as Adapted Primary Literature (APL), represents a key strategy for strengthening scientific learning. The positive perception demonstrated by teachers towards the use of APL indicates its potential as a teaching tool, provided it is accompanied by specific training to facilitate its effective application in the classroom.
14	Hidayat et al., (2020).	Incorporating resources aligned with the nature of science, such as Adapted Primary Literature (APL), requires specific teacher preparation, as positive perceptions do not guarantee effective implementation without adequate training. This underscores the need to design carefully structured training strategies.
15	Tshuma & Nyamupangedengu (2024).	The use of artistic methodologies such as drama in teacher training enhances understanding of scientific concepts and their connection to social and human aspects, increasing interest and engagement among future teachers. These experiences contribute to making science learning more accessible and meaningful.
16	Freire (2025)	Integrating the history, philosophy, and sociology of science in physics teaching contributes to a more critical, contextualized, and humanistic education, allowing teachers and students to reflect on the social, environmental, and cultural challenges of the 21st century.
17	Neves et al. (2025)	The analysis of national literature on the Project-Based Learning (PBL) methodology in basic science education shows that this strategy fosters the development of competencies and conceptual learning in students, adapting to various school realities. Although it faces certain challenges, documented experiences demonstrate its formative potential in diverse contexts.
18	Abbas et al. (2024)	Students' experiences with blended learning showed a favorable impact on their academic performance and commitment to the learning process, although technological difficulties were also evident, which could lead to frustration. This relationship suggests that infrastructure and digital resources are key factors influencing the quality of teaching experiences in science education, especially in hybrid contexts.
19	Caballero et al. (2024)	The implementation of artificial intelligence in basic education in Paraguay largely depends on teachers' capabilities, as specific competencies in ICT, programming, and computational thinking are required. This demonstrates that the impact of AI on science teaching is conditioned by factors related to teachers' training and preparation to leverage its pedagogical potential.

20	Umbarila-Castiblanco, & Cárdenas-Salgado (2023)	Experience shows that using models like the 3P and strategies like I4C, integrated within a Constructive Alignment approach, favors the development of critical thinking and understanding of key scientific concepts. This type of application evidences how certain didactic conditions within the classroom can directly influence the quality of learning.
21	Duque (2023)	The subject of morphophysiology significantly contributes to learning in health sciences by providing a solid conceptual foundation that is well-regarded by students. However, although the resources used by the teacher are perceived as adequate, challenges remain in fostering greater interaction and collaboration among peers.

Importance of teaching experiences for science learning

Teaching experiences play a fundamental role in science learning, especially when integrating approaches that link scientific knowledge with social, cultural, and human aspects. In this regard, the incorporation of artistic methodologies, such as drama, has been shown to enhance the understanding of complex concepts and increase the engagement of future educators by transforming the classroom into a space for active, critical, and meaningful participation (Tshuma et al., 2024). This humanization of scientific content is further enhanced by including the history, philosophy, and sociology of science, promoting deep reflection on the challenges of the 21st century and fostering contextualized, critical education for both students and teachers (Freire, 2025).

Additionally, methodological approaches such as Project-Based Learning (PBL) have demonstrated great effectiveness in teaching science, fostering the development of competencies and solid conceptual learning, particularly at the basic education level. Although these practices face challenges, they are adaptable to various educational realities and enrich scientific training by promoting autonomy and problem-solving skills in real-world contexts (Neves et al., 2025). Even in specialized subjects like morphophysiology, the appropriate design of teaching experiences is positively valued by students, who recognize the usefulness of the resources and content (Duque et al., 2023).

Factors influencing teaching experiences for science learning

Various contextual, pedagogical, and technological factors directly influence the quality of teaching experiences. The training and development of skills are strengthened by variables such as clinical supervision, accumulated experience, and a favorable institutional environment. When these elements are adequately articulated, they positively impact pedagogical competencies, highlighting the importance of continuous training programs that address these dimensions (Turnadi et al., 2023).

On the other hand, teachers' pedagogical beliefs determine how they integrate digital resources in the classroom. Some opt for active methodologies that promote student autonomy, while others maintain traditional approaches that limit technological potential, indicating the need to consider these differences in teacher training (Chen et al., 2023). This diversity is also observed in hybrid contexts, where blended learning improves performance and participation; however, its effectiveness depends on technological availability and teacher preparedness, as deficiencies in these areas can lead to frustration and limit impact (Abbas et al., 2024).

Moreover, large-scale studies show that variables such as socioeconomic status, school climate, and type of institution have a strong correlation with performance in scientific literacy. In contrast, traditionally valued factors, such as teaching experience or participation in professional development programs, do not always present a direct impact, prompting a reevaluation of the school conditions that truly favor learning (You et al., 2021). This is particularly relevant in initiatives like the incorporation of artificial intelligence in basic education, where success depends not only on technology but also on teacher preparation in areas such as programming and computational thinking, making technological training a key factor (Caballero et al., 2024).

From a didactic perspective, it has been demonstrated that using frameworks like the 3P model and strategies like I4C, applied within a Constructive Alignment approach, significantly enhances critical thinking and conceptual understanding in science. This evidence shows how internal factors in instructional design can profoundly influence learning, beyond the content itself (Umbarila-Castiblanco et al., 2023).

Strategies to strengthen teaching experiences in science learning

Strengthening science learning requires rethinking strategies in teacher training. In primary education, there is an urgent need to improve the implementation of formative assessment, as it currently does not meet the

standards necessary to promote effective learning (Alali et al., 2025). In response to this challenge, some emerging strategies have shown promising results.

For example, the flipped classroom model, complemented by animations on whiteboards and educational modules, has proven to enhance self-regulation, critical thinking, and communication among both pre-service and in-service teachers, being especially relevant in the context of digital transformation driven by Industry 4.0 (Suwardika et al., 2024). In this scenario, teaching experience appears to have a greater influence than prior academic training on the understanding and mastery of scientific content (Septiyanto et al., 2024).

However, strategies like the STEM approach, although valued, face difficulties when lacking solid preparation. The lack of practical experience, especially among less experienced teachers, limits effective implementation, highlighting the need for sustained pedagogical support (Indriyanti et al., 2023). Similarly, prolonged professional development programs can transform the epistemic perspectives of early childhood educators toward practices centered on knowledge generation, although these changes do not always occur uniformly, necessitating differentiated training strategies (Lammert et al., 2023).

Other innovative methodologies, such as garden-based learning, have shown a positive impact by strengthening students' perceptions of competence, belonging, and autonomy. This strategy combines practical outdoor activities with scientific content, fostering a deeper emotional and cognitive connection with the environment (Riggs et al., 2022). In initial training, inquiry-based approaches have established themselves as key tools that articulate scientific and didactic content, promoting a critical and student-centered teaching style (Tierno et al., 2022).

Finally, the incorporation of digital tools, such as the Socrative platform, allows for immediate and varied feedback, promoting self-regulated learning and strengthening the autonomy of future educators (Fraile et al., 2021). During the pandemic, the design of training spaces based on the principles of Universal Design for Learning (UDL) demonstrated the ability to strengthen teacher self-efficacy, regardless of gender or prior experience, highlighting its long-term applicability potential (Leonardo et al., 2021).

Additionally, the use of materials aligned with the nature of science, such as Adapted Primary Literature (APL), has been well received by teachers. However, effective implementation requires specific training to leverage its pedagogical potential, as a positive perception alone does not guarantee proper integration in the classroom (Ryane et al., 2020; Hidayat et al., 2020).

Conclusions

The study concludes that teaching experiences play a fundamental role in science learning, especially when integrating approaches that link scientific knowledge with social, cultural, and human aspects. In this regard, methodologies such as Project-Based Learning (PBL) have proven effective in fostering the development of competencies and solid conceptual learning, particularly at the basic education level. These methodologies enrich scientific training by promoting autonomy and the ability to solve problems in real-world contexts.

Furthermore, various contextual, pedagogical, and technological factors directly influence the quality of teaching experiences. Clinical supervision, accumulated teacher experience, and a favorable institutional environment are key elements that, when adequately articulated, generate a positive impact on pedagogical competencies. Therefore, it is essential to design continuous training programs that address these fundamental dimensions of the educational environment.

Additionally, some teachers opt for active methodologies that promote student autonomy, complemented by initiatives such as the incorporation of artificial intelligence, the flipped classroom, animations on whiteboards, and educational modules. The use of platforms like Socrative facilitates immediate and varied feedback, strengthening the learning process. Finally, the utilization of materials aligned with the nature of science has demonstrated the potential to enhance self-regulation, critical thinking, and communication among both pre-service and in-service teachers.

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