EXPLORING THE IMPACT OF COMPUTATIONAL THINKING ON TEACHER EDUCATION: A SYSTEMATIC REVIEW

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ABSTRACT

Objective: The objective of this study is to investigate the role of computational thinking in teacher training, in order to identify the main practices and trends in this field and examine their implications for technological education.

Theoretical Framework: This study presents a review of the key concepts related to computational thinking in the educational field. Existing definitions and approaches are highlighted, as well as models and theories that support the integration of computational thinking in teacher training.

Method: The methodology adopted included an exhaustive search in five academic databases to identify relevant studies published in the last five years. Inclusion and exclusion criteria were applied to select the relevant articles, and a systematic analysis was carried out to synthesize the findings.

Results and Discussion: The results revealed a variety of experiences and practices related to computational thinking in teacher training. In the discussion section, these results were contextualized in the light of the theoretical framework, highlighting the implications for educational practice and identifying areas of future research.

Implications of the research: The practical and theoretical implications of this study are discussed, providing information on how the results can influence the teaching and learning of computational thinking in the context of teacher training. These implications could include the design of professional development programs and the development of technology-focused educational curricula.

Originality/Value: This study contributes to the literature by providing an updated view of the state of computational thinking in teacher training. Its relevance and value are evidenced in its ability to inform the design of effective educational interventions in the field of technological education.

Keywords: Computational Thinking, Teacher Training, Technological Education, Systematic Review, Teaching Strategies, Educational Trends.

RESUMO

Objetivo: O objetivo deste estudo é investigar o papel do pensamento computacional na formação de professores, a fim de identificar as principais práticas e tendências neste campo e examinar suas implicações para a educação tecnológica.

Estrutura Teórica: Este estudo apresenta uma revisão dos conceitos-chave relacionados ao pensamento computacional no campo educacional. As definições e abordagens existentes são destacadas, bem como os modelos e teorias que apoiam a integração do pensamento computacional na formação de professores.

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Exploring the Impact of Computational Thinking on Teacher Education: A Systematic Review

Método: A metodologia adotada incluiu uma pesquisa exaustiva em cinco bases de dados acadêmicas para identificar estudos relevantes publicados nos últimos cinco anos. Foram aplicados critérios de inclusão e exclusão para selecionar os artigos relevantes, tendo sido realizada uma análise sistemática para sintetizar os resultados.

Resultados e Discussão: Os resultados revelaram uma variedade de experiências e práticas relacionadas ao pensamento computacional na formação de professores. Na seção de discussão, esses resultados foram contextualizados à luz do marco teórico, destacando as implicações para a prática educacional e identificando áreas para futura pesquisa.

Implicações da pesquisa: As implicações práticas e teóricas deste estudo são discutidas, fornecendo informações sobre como os resultados podem influenciar o ensino e aprendizagem do pensamento computacional no contexto da formação de professores. Essas implicações podem incluir a concepção de programas de desenvolvimento profissional e o desenvolvimento de currículos educativos centrados na tecnologia.

Originalidade/valor: Este estudo contribui para a literatura, fornecendo uma visão atualizada do estado do pensamento computacional na formação de professores. Sua relevância e valor são evidenciados em sua capacidade de informar a concepção de intervenções educacionais eficazes no campo da educação tecnológica.


EXPLORANDO EL IMPACTO DEL PENSAMIENTO COMPUTACIONAL EN LA FORMACIÓN DOCENTE: UNA REVISIÓN SISTEMÁTICA

RESUMEN

Objetivo: El objetivo de este estudio es investigar el papel del pensamiento computacional en la formación de maestros, con el propósito de identificar las principales prácticas y tendencias en este campo y examinar sus implicaciones para la educación tecnológica.

Marco Teórico: En este estudio se presenta una revisión de los conceptos claves relacionadas con el pensamiento computacional en el ámbito educativo. Se destacan las definiciones y enfoques existentes, así como los modelos y teorías que sustentan la integración del pensamiento computacional en la formación de maestros.

Método: La metodología adoptada comprendió una búsqueda exhaustiva en cinco bases de datos académicas para identificar estudios pertinentes publicados en los últimos cinco años. Se aplicaron criterios de inclusión y exclusión para seleccionar los artículos relevantes, y se realizó un análisis sistemático para sintetizar los hallazgos.

Resultados y Discusión: Los resultados revelaron una variedad de experiencias y prácticas relacionadas con el pensamiento computacional en la formación de maestros. En la sección de discusión, se contextualizaron estos resultados a la luz del marco teórico, destacando las implicaciones para la práctica educativa y identificando áreas de investigación futura.

Implicaciones de la investigación: Se discuten las implicaciones prácticas y teóricas de este estudio, proporcionando información sobre cómo los resultados pueden influir en la enseñanza y el aprendizaje del pensamiento computacional en el contexto de la formación docente. Estas implicaciones podrían abarcar el diseño de programas de desarrollo profesional y la elaboración de currículos educativos centrados en la tecnología.

Originalidad/Valor: Este estudio contribuye a la literatura al proporcionar una visión actualizada del estado del pensamiento computacional en la formación de maestros. Su relevancia y valor se evidencian en su capacidad para informar el diseño de intervenciones educativas efectivas en el ámbito de la educación tecnológica.

Palabras clave: Pensamiento Computacional, Formación Docente, Educación Tecnológica, Revisión Sistemática, Estrategias de Enseñanza, Tendencias Educativas.

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1 INTRODUCTION

In the current context of rapid technological evolution, the integration of computational thinking in teacher training emerges as a primary need to prepare future teachers for the challenges of the digital age (Pincay & Cuero, 2024). This study focuses on responding to how computational thinking can be effectively integrated into teacher training, as well as identifying best practices and pedagogical approaches to achieve this. The rationale for this research lies in the importance of understanding the effective teaching of computational thinking to improve the quality of education and to prepare teachers for the digitized environment. In this sense, the main objective of this work is to carry out a systematic review of the literature on computational thinking in teacher training, with the purpose of identifying the main practices and trends in this field.

This objective is divided into identifying the existing definitions and approaches of computational thinking in the educational context, analyzing the practices and methodologies used to teach computational thinking in teacher training, and evaluating the impact of computational thinking on the educational process and the professional development of teachers.

2 THEORETICAL FRAMEWORK

2.1 CONSTRUCTIVISM IN TEACHER TRAINING

Constructivism in teacher training promotes active and constructive learning, where students build their knowledge from their experiences, interactions and reflections (Cohen, 2008). It involves student-centered pedagogical practices and their active participation in their own learning process. Future teachers are encouraged to reflect on their experiences, question assumptions and collaborate with their peers to build knowledge collectively (Vega Granda et al., 2023). In addition, the use of active teaching strategies, such as problem-based learning, teamwork and guided exploration, is encouraged, allowing students to build their understanding through interaction with content and peers.

Constructivism in teacher training implies a change in the conception of knowledge as something that is actively built rather than passively transmitted. From this perspective, future teachers not only acquire information during their training, but participate in the active construction of their own understanding through interaction with content, reflection on their
own experiences and collaboration with other students (Bolaños, 2020). Oh, yeah. This approach recognizes the importance of teachers developing a deep understanding of learning processes and how these can be facilitated in the classroom to promote more meaningful and lasting understanding by students.

One of the main implications of constructivism in teacher training is that teachers should act as facilitators of learning, rather than as transmitters of knowledge. Instead of simply imparting information, teachers should create stimulating learning environments that promote exploration, experimentation, and reflection (Sanchez, 2023). Oh, yeah. This implies that teachers must be able to tailor their teaching to the individual needs of students, offering support and guidance as students build their own knowledge.

Constructivism in teacher training emphasizes a personalized and active approach, valuing the diversity of experiences and learning styles (Bolaños, 2020). Oh, yeah. Teachers are encouraged to use strategies such as problem-based learning and teamwork to facilitate students' understanding.

2.2 SITUATED AND CONTEXTUALIZED LEARNING

Situated Learning Theory underscores the relevance of the real context in the development of skills and knowledge (López et al., 2021). Oh, yeah. In teacher training, this involves teaching computational thinking in an integrated and contextualized way, reproducing professional situations (Garrido, 2023). Oh, yeah.

In addition, Situated Learning Theory underscores the importance of collaborative learning and active participation in communities of practice. Therefore, in the context of teacher training, students are encouraged to collaborate with each other and participate in problem-solving activities that mimic the dynamics of teamwork in an educational environment (Alcalá Ibáñez & Gasque Rubio, 2023). Oh, yeah.

Situated and contextualized learning is a pedagogical approach that recognizes the importance of placing learning in authentic and meaningful contexts for students (Alvarez, 2020). Oh, yeah. In the context of teacher training, this approach involves the creation of learning experiences that reflect the challenges and situations that future teachers will face in their professional practice (Ripoll, 2021). Oh, yeah. This may include opportunities for students to engage in hands-on activities, such as class observation, student mentoring, and planning and teaching real lessons in real school settings.

Situated and contextualized learning highlights the collaboration and connection.
between theory and practice. Prospective teachers interact in real educational settings, giving them deeper understanding and practical skills (Gómez et al., 2020) Oh, yeah. This integration allows them to apply fundamental pedagogical concepts effectively (Beltrán et al., 2023) Oh, yeah. This integration between theory and practice allows students not only to understand the fundamental pedagogical principles, but also to develop the necessary skills to apply them effectively in their teaching practice.

In addition, situated and contextualized learning promotes a deeper and more meaningful understanding of curricular content by linking it to students' daily lives and experiences. Prospective teachers are challenged to design and facilitate learning activities that are relevant and meaningful to students, connecting curriculum content with their interests, experiences, and cultural contexts (Leiva & Llancaqueo, 2023) Oh, yeah. This connection between classroom and real-world learning not only increases students' motivation and commitment, but also helps them develop a deeper and more lasting understanding of content, leading to more effective and meaningful learning.

Situated and contextualized learning encourages critical reflection in future teachers, encouraging them to identify challenges, opportunities and effective strategies in their teaching practice (Méndez, 2024) Oh, yeah. This facilitates the integration of theory and practice and continuous professional development.

2.3 PREVIOUS RESEARCH ON COMPUTATIONAL THINKING IN TEACHER TRAINING

The teaching of computational thinking to teachers is fundamental to properly prepare them in the delivery of digital skills to their students. This type of training gives them the opportunity to immerse themselves in the world of programming, allowing them not only to acquire technical skills, but also to understand in depth the fundamental principles of computational thinking, such as algorithmic thinking, problem solving, abstraction and computational logic (González-Martínez et al., 2023) Oh, yeah. As future teachers face programming challenges and work on creating solutions to specific problems, they develop key cognitive and metacognitive skills that are critical to computational thinking. In addition, this intensive training can foster a positive attitude towards technology and informatics, which could translate into greater confidence and willingness to integrate technological tools and resources into their teaching practice (Villalustre, 2024) Oh, yeah. Intensive programming training not
only prepares prospective teachers to teach computer skills to their students, but also provides them with a solid foundation for promoting computational thinking in the classroom.

2.4 COGNITIVE LOAD THEORY

Cognitive Load Theory posits that an individual's cognitive processing capacity is limited and that effective learning involves proper management of this load (Sobarzo & Arroyo, 2023)Oh, yeah. In the context of teacher training, this theory suggests that the design of teaching activities and materials related to computational thinking should take into account the student's cognitive load. By using teaching strategies that minimize cognitive load, such as information segmentation and the use of visual aids, learning and understanding of concepts related to computational thinking is facilitated (Leiva & Llancaqueo, 2023)Oh, yeah.

This theory provides an additional perspective on how to design and structure the teaching of computational thinking in teacher training, considering students' cognitive limitations and promoting more effective and meaningful learning.

3 METHODOLOGY

In this systematic review, the evidence-based research approach of the field of Software Engineering was adopted (Morales-carrillo et al., 2021)In addition, the purpose of this approach was to provide a comprehensive overview of a specific area of research, as well as to identify the amount, type and results of studies available in that area, allowing the construction of a classification scheme and a valid structure. This approach is widely accepted in the scientific community, as it facilitates the generation of knowledge from evidence collected in primary studies. In addition, Figure 1 presents the different stages of the defined method for conducting the review.

Figure 1
Structure systematic review.
3.1 RESEARCH QUESTIONS

The purpose of this study was to expose the findings obtained by applying a systematic review of the scientific literature related to Computational Thinking for teacher training. In order to elaborate the proposed state of the art, the following research questions were raised:

RQ1: What are the main pedagogical practices and approaches used in the integration of Computational Thinking in teacher training?

RQ2: What is the impact of Computational Thinking on the teaching and learning process in teacher training?

RQ3: What trends emerge in the scientific literature regarding Computational Thinking in teacher training?

3.2 SEARCH

The proposed search strategy consisted of the exploration of general terms in specialized databases. Key search terms were used, which were combined with synonyms in order to cover a wide variety of documents for evaluation. Table 1 details the search terms together with their respective synonyms and filters applied.

Table 1

<table>
<thead>
<tr>
<th>Search Terms</th>
<th>Synonyms</th>
<th>Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational thinking</td>
<td>Computational Logic Thinking, Computational Competences</td>
<td>Publication Year: Last 5 years</td>
</tr>
<tr>
<td>Publication Year: Last 5 years</td>
<td>Teacher Education, Teacher Preparation</td>
<td>Language: English and Spanish</td>
</tr>
<tr>
<td>Curriculum integration</td>
<td>Integrated ICT Teaching, Incorporation of Technology in the Classroom</td>
<td>Document Type: Scientific Articles</td>
</tr>
<tr>
<td>Impact on Teaching</td>
<td>Effect on Learning, Educational Outcomes</td>
<td></td>
</tr>
</tbody>
</table>

The search process was carried out in the databases mentioned in Table 2, considering fields such as title, keywords, summary and full document.
Table 2

*Main Terms and Databases*

<table>
<thead>
<tr>
<th>Term</th>
<th>Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational Thinking</td>
<td>Redalyc</td>
</tr>
<tr>
<td></td>
<td>Scopus</td>
</tr>
<tr>
<td></td>
<td>Doaj</td>
</tr>
<tr>
<td></td>
<td>ScienceDirect</td>
</tr>
<tr>
<td></td>
<td>IEEE Explorer</td>
</tr>
</tbody>
</table>

Table 3 presents the search string resulting from the main term along with its synonyms and corresponding filters.

Table 3

*Search string*

<table>
<thead>
<tr>
<th>Parent Term</th>
<th>Search string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational Thinking</td>
<td>(“computational thinking” OR “Computational abstraction” OR “Thinking computationally” OR “Programming teaching environments” OR “Computational logic”) AND (education with computational thinking) AND (publication year &gt;=2019)</td>
</tr>
</tbody>
</table>

3.3 SELECTION

In this review, all the studies considered were thoroughly analyzed, evaluating aspects such as title, keywords, summary, introduction, background, state of the art, methodology, results and conclusions.

In addition, inclusion and exclusion criteria were established for the review. The inclusion criterion consisted of scientific documents related to computational thinking studies for the training of teachers or their research synonyms. The exclusion criteria included studies without a corresponding bibliographic citation, documents that do not contain the search terms or synonyms, as well as experiences solely related to computational thinking and documents not available for download.

The process of selecting studies was carried out in five stages, corresponding to each of the five specialized databases considered. Each moment comprised three phases:

- Phase 1: Deletion of duplicate items.
- Phase 2: Removal of non-downloadable items.
- Phase 3: Application of inclusion and exclusion criteria.

Details of the dates for viewing and downloading files are presented in Table 4.
Table 4

File View and Download Dates

<table>
<thead>
<tr>
<th>Databases</th>
<th>Search Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redalyc</td>
<td>02/01/2024</td>
</tr>
<tr>
<td>Scopus</td>
<td>02/09/2024</td>
</tr>
<tr>
<td>Doaj</td>
<td>05/03/2024</td>
</tr>
<tr>
<td>ScienceDirect</td>
<td>02/04/2024</td>
</tr>
<tr>
<td>IEEE Explorer</td>
<td>15/01/2024</td>
</tr>
</tbody>
</table>

As a result of the database search, a total of 100 studies were identified, and after applying the inclusion and exclusion criteria, 50 documents were selected.

The selected documents were evaluated according to six criteria: origin of the sources, relevance of the content, clarity in the objective of the research, adequate description of the context in which the research was developed, clarity and rigor of the methodological design of the research, and scientific rigor in the analysis of the data.

The quality assessment of this systematic review involved the complete reading of the 40 documents, followed by the processes of elimination of duplicate and non-downloadable articles, as well as the application of inclusion and exclusion criteria, the process of which is detailed in Table 5.

Table 5

Quality Assessment in Search and Selection Processes

<table>
<thead>
<tr>
<th>Parent Term</th>
<th>Search Result</th>
<th>Duplicate files</th>
<th>Excluded files</th>
<th>Relevant files</th>
<th>Database</th>
</tr>
</thead>
<tbody>
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<td>Computational Thinking</td>
<td>50</td>
<td>10</td>
<td>18</td>
<td>10</td>
<td>Redalyc</td>
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<td></td>
<td>20</td>
<td>1</td>
<td>8</td>
<td>7</td>
<td>IEEE Explorer</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0</td>
<td>1</td>
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<td>Doaj</td>
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<td></td>
<td>5</td>
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<td>10</td>
<td>10</td>
<td>Science Direct</td>
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<tr>
<td></td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>Scopus</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>13</strong></td>
<td><strong>37</strong></td>
<td><strong>40</strong></td>
<td></td>
</tr>
</tbody>
</table>

3.4 DATA EXTRACTION AND SYNTHESIS OF RESULTS

Once the search for the terms in each database has been completed and the three phases applied in each of them, and taking into account that the main objective of this systematic study is to determine the state of the art of Computational Thinking for the initial training of teachers, the findings found in the relevant files are presented below along with their respective author quotes.
4 RESULTS AND DISCUSSIONS

4.1 MAIN PEDAGOGICAL PRACTICES AND APPROACHES IN THE INTEGRATION OF COMPUTATIONAL THINKING IN TEACHER TRAINING

The results reveal varied practices to teach computational thinking to teachers, such as practical activities, use of technology and real projects. These strategies promote computational thinking in different areas of the curriculum.

Among the practices identified, practical activities of coding and problem solving stand out, in which students interact directly with technology and apply computational concepts in specific situations. These activities not only facilitate the acquisition of technical skills, but also the development of cognitive skills, such as algorithmic thinking and problem solving (Minga et al., 2024). Oh, yeah.

In addition, the use of specific technological tools and resources designed to support the learning of computational thinking, such as visual programming platforms or integrated development environments, is observed. These tools allow students to experiment with computational concepts in a practical and accessible way, thus promoting their understanding and mastery (Solano et al., 2023). Oh, yeah.

On the other hand, the application of project-based pedagogical approaches is evidenced, where students approach real-world problem solving using computational thinking as a tool. These projects aim not only to develop technical skills, but also to foster creativity, teamwork and the application of computational concepts in authentic contexts (Betancourt & Cruz, 2021). Oh, yeah.

Project-based learning was identified as an effective pedagogical practice for the integration of computational thinking into teacher training. The reviewed studies highlight the usefulness of programming and problem-solving projects as vehicles for the development of computational thinking skills among education students (Herrera, 2024). Oh, yeah. Evidence was found that problem-solving approaches are fundamental to teaching computational thinking in teacher training. Teachers can use problem-solving strategies to help students break down complex problems into more manageable steps, identify patterns, and develop algorithms for their solution (Parra, 2022).

Revised studies suggest that the integration of programming tools and platforms into the teacher training curriculum can be highly effective in promoting computational thinking. Tools such as Scratch, Python and Blockly provide accessible and friendly programming
environments that allow students to experiment with computational concepts in a practical way (Losada & Peña, 2022) Oh, yeah. Collaborative and peer-learning approaches are beneficial for the development of computational thinking in teacher training. Collaboration between students enables knowledge sharing, joint problem solving, and critical and creative thinking in a supportive environment (Álvarez et al., 2020) Oh, yeah.

Formative evaluation and reflection were identified as key components in the integration of computational thinking in teacher training. Teachers can use formative assessment strategies, such as rubrics and timely feedback, to monitor student progress and provide personalized guidance to improve their understanding and skills in computational thinking (Crusader, 2022) Oh, yeah.

In addition to the pedagogical practices and approaches mentioned above, it is crucial to highlight the importance of curricular adaptation and the contextualization of computational thinking in teacher training. In this sense, it was found that curriculum flexibility, together with the contextualization of concepts, plays a fundamental role in the effective integration of computational thinking in education (Quiroz-Vallejo et al., 2021) Oh, yeah. Therefore, it is imperative to develop curricula that can dynamically adapt to the changing needs of students and diverse educational contexts. It also highlights the need to contextualize computational thinking concepts and skills in situations and problems relevant to teaching practice, which can increase students' motivation and commitment in the learning process (Aparicio, 2023) Oh, yeah. Move away from the realities and challenges of the educational environment in which you work. Through attention to the diversity of student contexts and experiences, a deeper and more meaningful understanding of computational thinking, as well as its practical application in diverse educational settings, can be facilitated.

4.2 IMPACT OF COMPUTATIONAL THINKING ON THE TEACHING AND LEARNING PROCESS IN TEACHER EDUCATION

The impact of computational thinking on the teaching and learning process in teacher training is significant and multifaceted. It has been observed that the integration of computational thinking into the teacher training curriculum can promote a more student-centered and active approach in the classroom, where future teachers not only acquire technical skills, but also develop problem-solving skills, critical thinking, and creativity (Restrepo, 2024) Oh, yeah. Teaching computational concepts, such as programming and algorithmic problem solving, can enhance the ability of prospective teachers to design and facilitate authentic and relevant learning experiences for their students that foster critical thinking and
collaboration (Adam, 2024) Oh, yeah. In addition, the introduction of digital tools and technologies in the teaching and learning process can expand opportunities for student access and participation, as well as promote a greater diversity of pedagogical approaches and learning styles in the classroom (Coll Salvador et al., 2023) Oh, yeah. In short, computational thinking has the potential not only to transform the way teachers are taught and learned in teacher training, but also to prepare future teachers to face the challenges and opportunities of an increasingly digitalized society.

The literature review indicates that the integration of computational thinking in teacher training has several positive impacts on the teaching and learning process. There is a significant improvement in problem solving and decision-making, the development of critical and creative thinking skills, as well as an increase in student interest and participation in learning (Martinez et al., 2022) Oh, yeah. It also highlights the preparation of future teachers to teach computational thinking skills to their students. These findings highlight the importance of computational thinking in teacher training as a tool to improve the quality of education (Camargo Pérez & Munar Ladino, 2021) Oh, yeah.

Computational thinking has emerged as a fundamental element in the teaching and learning process in teacher training, significantly influencing various facets of education (Vilanova, 2023) Oh, yeah. First, this approach revolutionizes the way future educators approach educational challenges. By introducing concepts such as problem decomposition, pattern recognition, abstraction, and algorithmic design, computational thinking provides them with tools to tackle problems in a more structured and analytical way. This ability to break down complex problems into more manageable components and then develop effective solutions becomes an invaluable asset in any teacher's arsenal (Ramos-Rivadeneira & Jiménez-Toledo, 2023)

In addition, computational thinking promotes the development of critical thinking among future educators. By teaching them to analyze problems from multiple perspectives, to identify and evaluate relevant evidence, and to make informed decisions, this approach equips them with essential skills to address educational challenges in a thoughtful and effective manner (Aranda, 2017) Oh, yeah. Beyond problem solving, critical thinking fosters an attitude of inquiry and curiosity among teachers, contributing to a dynamic and stimulating learning environment.

Importantly, the impact of computational thinking is not limited to the realm of computer science. Its principles and processes can be effectively applied across a wide range of disciplines, from the sciences to the humanities. Therefore, by integrating computational
thinking into teacher training, they are trained to teach relevant and transferable skills that are fundamental in the contemporary world.

In addition, computational thinking drives innovation in teaching by enabling teachers to effectively harness technology in the classroom. From the design of digital educational resources to the implementation of data analysis tools to customize instruction (Coronel Díaz & Lima Silvain, 2020). Moreover, educators can use computational thinking to create more interactive, student-centered learning experiences. This ability to adapt and use emerging technologies creatively and productively is critical in a world where technology is rapidly transforming the way we live and work.

The integration of computational thinking into teacher training prepares educators, and thus their students, for the future of work. In an increasingly digitized and technology-oriented world, computer-thinking skills are increasingly in demand in a variety of professional fields (Méndez Hernández & Fernando Bermúdez, 2023). Oh, yeah. By equipping teachers with these skills, you ensure that they are prepared to meet the challenges and take advantage of the opportunities that arise in the future of their students' work.

4.3 EMERGING TRENDS IN SCIENTIFIC LITERATURE REGARDING COMPUTATIONAL THINKING IN TEACHER EDUCATION

Several emerging trends were identified in the scientific literature on computational thinking in teacher training:

**Curricular Integration:** There is a growing interest in the integration of computational thinking in the teacher training curriculum, both in undergraduate and graduate programs (Díaz Barriga, 2020). Oh, yeah. The studies highlight the importance of developing computational thinking skills among future teachers to prepare them for a digitally competent world.

**Pedagogical Approaches:** Various pedagogical strategies and approaches are explored to teach and learn computational thinking in educational contexts. Effective teaching methods are investigated, including project-based learning, collaborative work, and the use of programming tools and environments (Díaz Barriga, 2020).

**Teacher Professional Development:** The impact of computational thinking on the professional development of practicing teachers is investigated. Professional development programs, training initiatives and communities of practice that promote the effective integration of computational thinking in teaching and learning are explored (Díaz Barriga, 2020). Oh, yeah.
A prominent trend in the literature is the increasing attention to inclusion and equity in the teaching of computational thinking in teacher training. Researchers are exploring how to address disparities in access to and participation in computer education, particularly among underrepresented groups such as women, ethnic minorities, and low-income students (Lagla et al., 2023). Educational strategies and resources are being developed that promote diversity and inclusion in learning computational thinking, as well as teacher training programs that incorporate culturally relevant and gender-sensitive approaches (Restrepo, 2024). In addition, research is ongoing on how computational thinking can be used as a tool to address social and community issues, such as social justice, environment and health, and how teachers can integrate these dimensions into their teaching to promote positive change in their communities (Restrepo, 2024). These initiatives reflect a growing commitment to equity and social justice in computer education and have the potential to expand access to and participation in computational thinking among all students.

5 CONCLUSION

This systematic review has explored the impact of computational thinking on teacher training, with the aim of analyzing emerging trends in scientific literature and their implications for educational practice. Through an exhaustive analysis of the current literature, several significant trends were identified that reflect the growing interest in the integration of computational thinking in teacher training.

The findings of this review highlight the importance of considering computational thinking as a fundamental competence for teachers in the digital age. The effective integration of computational thinking into the teacher training curriculum can promote the development of critical and creative skills among future educators, preparing them to face the challenges of an increasingly technological world.

Several areas of opportunity for future research were identified, including the design and implementation of teacher training programs focused on computational thinking, the evaluation of the impact of computational thinking on pedagogical practice and teacher professional development, and the exploration of effective strategies for teaching and learning computational thinking in diverse educational contexts.

In conclusion, this review highlights the importance of considering computational thinking as a fundamental element in teacher training and highlights the need to continue researching and developing innovative educational practices that promote computational thinking among all students.
thinking among educators of the future. This research has the potential to improve the quality of teaching and learning in an increasingly digitized world, preparing teachers to lead and transform 21st century education.

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Exploring The Impact of Computational Thinking on Teacher Education: A Systematic Review


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