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Didactic Trends for The Development and Strengthening of Computational Thinking in The Student Population

Tendencias Didácticas Para El Desarrollo Y Fortalecimiento Del Pensamiento Computacional En La Población Estudiantil

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Abstract

The objective of this review article is to trace the main research carried out in the international context on the trends that are being registered regarding Computational Thinking in the student population, as a component of the Fourth Industrial Revolution or the so-called Industry 4.0. Methodologically, forty investigations were reviewed, including doctoral theses, indexed scientific articles and institutional research, based on a search in the Scopus bibliometric engine. These references were processed from two fundamental categories: Computational Thinking and Information and Communications Technologies; the sources of the topic, with emphasis on the interpretation and understanding of both categories from the academy. A notable growth in the production of research in Spanish was noted, with a very similar production in latitudes such as Asia, Europe and Latin America; Most research dates back to the last decade, in pre-pandemic times as well as during and post-pandemic; Likewise, it is worth highlighting a trend in the development of qualitative methodologies aimed at establishing

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perceptions of their participating subjects, whose main techniques obey the projective ones, including observation, the semi-structured interview and the focus group. By systematizing the findings, it was possible to conclude that, on the continents, both Asian and European, the teaching models in the computational field begin from early or school ages with their emphasis on the programming language, in order to scale the levels that, both in Asia and in Europe and America, include primary, secondary and higher education, as well as for adults. Likewise, there is demand, especially in Latin America, for continuous training programs for those teachers who lack computer skills and use of technological tools.

Keywords: computational thinking, technological devices, science and technology, Industry 4.0.

Resumen

El objetivo de este artículo de revisión es rastrear las principales investigaciones realizadas en el contexto internacional sobre las tendencias que se registran en torno al Pensamiento Computacional en la población estudiantil, como componente de la Cuarta Revolución Industrial o la denominada Industria 4.0. Metodológicamente, se revisaron cuarenta investigaciones, incluyendo tesis doctorales, artículos científicos indexados e investigaciones institucionales, con base en una búsqueda en el motor bibliométrico Scopus. Estas referencias se procesaron a partir de dos categorías fundamentales: Pensamiento Computacional y Tecnologías de la Información y las Comunicaciones; las fuentes del tema, con énfasis en la interpretación y comprensión de ambas categorías desde la academia. Se observó un notable crecimiento en la producción de investigación en español, con una producción muy similar en latitudes como Asia, Europa y América Latina; la mayoría de las investigaciones datan de la última década, tanto en épocas prepandemia como durante y pospandemia; asimismo, cabe destacar una tendencia en el desarrollo de metodologías cualitativas orientadas a establecer percepciones de sus sujetos participantes, cuyas principales técnicas obedecen a las proyectivas, incluyendo la observación,

la entrevista semiestructurada y el grupo focal. Al sistematizar los hallazgos, se concluyó que, tanto en Asia como en Europa, los modelos de enseñanza en el campo computacional comienzan desde edades tempranas o escolares, con énfasis en el lenguaje de programación, para escalar los niveles que, tanto en Asia como en Europa y América, incluyen la educación primaria, secundaria y superior, así como para adultos. Asimismo, existe una demanda, especialmente en Latinoamérica, de programas de formación continua para docentes con deficiencias en habilidades informáticas y en el uso de herramientas tecnológicas.

Palabras clave: pensamiento computacional, dispositivos tecnológicos, ciencia y tecnología, Industria 4.0.

1. Introduction

Education, as a fundamental part of human development, plays an important role in the formation of individuals who are capable of facing the challenges of the contemporary world. As an integral part of it is the teaching and learning process, which allows the construction of knowledge and is the key to forming individuals with the skills to observe, understand, adapt, create and transform the world. The current dynamics of globalization, modernization and technological development impose great challenges on societies, individuals and education [1]. In the context of an education based on the Fourth Industrial Revolution or Industry 4.0, including emerging ICT technologies, that is relevant and contextualized, that tends to develop in students the skills and competencies required in this field, with a comprehensive approach, begins with the preparation of trained teaching staff, with skills and competencies to guide educational processes in Computational Thinking-PC- efficiently. That is why the problems present in the teaching processes of PC education were addressed from specific teaching strategies for PC and Technology education [2].

Understanding that learning [3] “is a lasting change in behavior or the ability to behave in a certain way, which is the result of practice or other forms of experience” (p.3). The above implies that the teacher, in his or her educational practice, must diversify his or her teaching strategies to address the different rhythms and learning styles of students, as well as focus on creating comprehensive learning experiences that produce significant and lasting changes in students. In today's dynamic education landscape, the teaching strategies used in the teaching and learning process play a fundamental role in the effectiveness of the teaching and learning process. That is why, based on updated pedagogical research, they must adapt, renew, reinvent themselves, innovate and evolve permanently. Integrate effectively, efficiently, contextually and pertinently into the institutions' curriculum and consequently become part of the teaching practices in the classroom to achieve a comprehensive education that not only transfers knowledge, but also develops skills and competencies. This holistic approach seeks to train individuals capable of facing the challenges of the 21st century in a responsible, ethical, sustainable and, especially, inclusive manner, which is currently demanded from educational institutions worldwide [4].

From the international context, [5] states that postmodern man observes reality through the focus of technology whose purpose is centered on the search for power, on the image through platforms such as Facebook and Instagram and the management of resources aimed at feeding interests. This being is by nature individualistic, it no longer seeks the common good but rather its particular well-being, but it should not be left alone with this vision, on the contrary, it should observe the opportunities that technology provides in postmodernity so that humanity can climb the ladder of civilization. In the field of education, technology has collaborated to improve didactics in different areas, but it must be understood that by itself it does not educate since it does not include the production and participation of cognitive processes, that is, it is distanced from the concept of artificial intelligence, a construct that must be worked on in the field of ICT

today; Furthermore, in the different pedagogical models it is sought that the educator is not only a technician who puts the technological devices into operation and teaches his students to maneuver the machines, but rather that he is sought to take them by the hand so that the student becomes an ideal man with comprehensive training [6].

The new ICTs show a wide variety of tools to increase the proposals of the teaching and learning process; It shows new horizons, it allows communication with other spaces, cultures and times in which the humanization of students must be sought. Hence, educational centers become meeting points for the new realities of postmodernity, it is here where PC provides the formation of a humanistic consciousness in the student, where he uses abstraction and the construction of algorithms to solve problems that arise in daily life [7]. The authors [8] propose that the incorporation of ICT in education should be a pedagogical decision based on the improvement of teaching and learning processes, and it is necessary for teachers to have adequate training in the use of technologies and to be able to integrate them effectively in classroom activities or educational practices. Furthermore, the authors emphasize that ICT should not be considered as an end in itself, but as a tool that facilitates the acquisition of knowledge and the development of skills by students. It is important that teachers use technologies creatively and promote the active participation of students in their learning process.

As a consequence of the above, in the current post-pandemic era, one of the challenges of the new teaching and learning model is to accompany students and their families to guarantee the adequate training process, since the global crisis caused by the pandemic has put households to the test, assigning them new and varied roles, aimed at creating spaces where dialogue and the general well-being of all its members are promoted, so the incorporation of ICT requires that the school reinvent itself and organize a new culture. digital, train teachers in the use of

technological devices for comprehensive training, and emotional support for the student and their family [9].

No less important is to consider the orientation that has been given to the educational policies of the different countries in Latin America in relation to the incorporation of ICT in the educational system, which are based on four (4) main axes: economic development, equity and social justice, pedagogical change, and quality in learning, but with an important change in recent years, since the political interest has gone from a quantitative logic, by mentioning how many computers, how many connected schools, what number of hours of technology and computing per week they teach. educational institutions, to another qualitative vision, where the contributions of educational research to the economic development of a country and to closing the gap of social inequalities acquire greater importance [10].

However, the gap continues to be evident in the Latin American Region, the gaps continue to widen compared to the great world powers and even compared to countries in the same region, taking into account the results obtained and socialized in the Education Sector Plan 2020-2024, in the case of Colombia which, according to the Organization for Economic Cooperation and Development [12] express that in the latest report of the International Standardized Test PISA (2018), students obtained a performance lower than the average of the Organization for Economic Cooperation and Development (OECD) in reading (412 points), mathematics (391) and science (413). Socioeconomically advantaged students outperformed disadvantaged students in reading by 86 points. This network offers digital resources, both for students and teachers that can contribute to the teaching and learning process; The main recipients are the teachers to whom the wide world of the Internet is made available for educational purposes, since on this platform the teacher finds plans, guides for teachers, multimedia resources, virtual learning objects (OVA), games and texts, among others. However, during the pandemic caused by Covid-19, students in the Region were not able to take advantage of this type of educational

resources, which is why, in the 2021 school year, they arrived at educational institutions with difficulties in terms of cognitive and socialization processes [13].

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For their part, students in rural areas, as they do not have technological devices, carry out actions to promote PC by using materials such as cardboard, paper, index cards, playground and board games. These types of activities are known as disconnected, which cause a large number of problems, classified by age and level of depth [14].

Finally, it is important to consider the possibilities of access to educational portals, in view of which it is necessary to specify that the Latin American Network of Educational Portals (RELPE)

since 2004, date on which it was created with the commitment of 17 countries in the region regarding the use of ICT in education.

2 Development of the theme

2.1 Conceptual bases

2.1.1 Computational Thinking-PC

As a background, in the sixties (60s), at the height of the programming boom and the first experiences in robotics, programming teaching was introduced to the educational system based on Piaget's theories, for which he developed a programming language for computers called Logo. Logo allowed students to build their knowledge by using a Turtle Robot that allowed them to solve problems [15]. From then on, programming languages such as MSXBasic, Turbo Pascal and Quick Basic began to be used in school. The importance given to them was so great that programming began to be taught at all levels of education from basic primary education to higher education; Therefore, the improvement of virtual programming environments has given relevance and aroused interest in bringing students closer to programming environments to develop the PC [16].

CP has had a significant impact in several countries. In the United States, its teaching has been promoted at all educational levels, from early childhood education to secondary school; Singapore has implemented the program titled Code for fun, to encourage computational thinking; Nigeria has included programming and the PC in its curriculum, giving them a leading role; For its part, Australia has introduced a subject focused on the development of computational thinking skills in its curriculum [17].

The development of the PC takes into account a series of levels, steps or components necessary to achieve its objectives. This ability poses an educational challenge for society by influencing different activities and fields of life such as science, technology and society, as stated by Wing (2008), in this sense it represents a type of analytical thinking that shares ideas

with mathematical thinking in problem solving, with engineering thinking with the design and evaluation of a large and complex system and also with scientific thinking with the approach to intelligence, mind and human behavior.

From these and other initial statements [18] expresses as significant cognitive components and processes, the reformulation of problems to make them solvable and familiar, recursion seeking to build a system incrementally, decomposition of a problem to make it manageable, abstraction and systemic tests through intentional measures.

In accordance with these considerations, it is convenient to analyze other contributions that categorize computational thinking. The following are analyzed as common elements [19]:

- Abstraction, this component extracts the essence of a system and is divided into three subcategories: data collection and analysis, pattern recognition and modeling.
- Decomposition, which refers to dissecting a complex problem or system into manageable and functional parts that form a whole. Additionally, there is the design of logical and ordered instructions in order to solve a problem, which in turn is subdivided into algorithm design, efficiency, automation and parallelism.
- Debugging, this element acts as an error identification factor focused on their detection and correction, iteration, for its part, refines solutions through the repetition of design processes and finally there is generalization, related to the transfer of PC skills to other situations or domains.

Continuing with the review of the steps that make up the PC, it is important to point out the contributions that [20] make in terms of its constituent components, also analyzed as specific skills and techniques that underpin it and directed towards problem resolution, system design and understanding of human behavior. To this end, they highlight, among others, the following fifteen categorical components: bottom-up analysis, refers to modules for solving a complex problem or task in different small, auxiliary or concrete problems; Top-down analysis is about approaching the solution of a problem from the most concrete to the most abstract; heuristics,

based on observation, analysis and recording of experience to solve problems; Divergent or lateral thinking refers to a way of generating ideas outside the usual pattern of thinking and, with regard to creativity as a human faculty resulting from divergent and convergent thinking, it is what allows generating unusual, unconventional, innovative, but also logical and defined results that are validable and unambiguous.

As stated in the previous statements about the levels or steps of PC, a diversity and heterogeneity is evident in the elements that compose it, however, from the point of view of different authors, some categories are similar and last over time such as abstraction, decomposition, generalization, problem resolution or systemic thinking while others differ in their concept but continue to group together characteristics of an intellectual work applied to data management practices that seek interaction with the real world seeking to provide solutions to problems of the same reality. [21]. 2.1.2 Information and Communications Technologies-ICT- As in the category on PC, this second category is referred to from a chronological view, beginning in the 1990s, when the use of ICT has deepened, which has transformed different areas of society [22]. Hence, ICT is defined as a diverse set of technological tools and resources used to communicate, create, disseminate, store and manage information [23]. There are various types of devices found on the market such as cell phones, electronic tablets, computers, among others. Likewise, on the Internet ICT connection point a diversity of consultation content has been generated, ranging from blogs, web pages, social networks, simulators, encyclopedias, online games, and others. ICTs are characterized by allowing interconnection and interaction between users.

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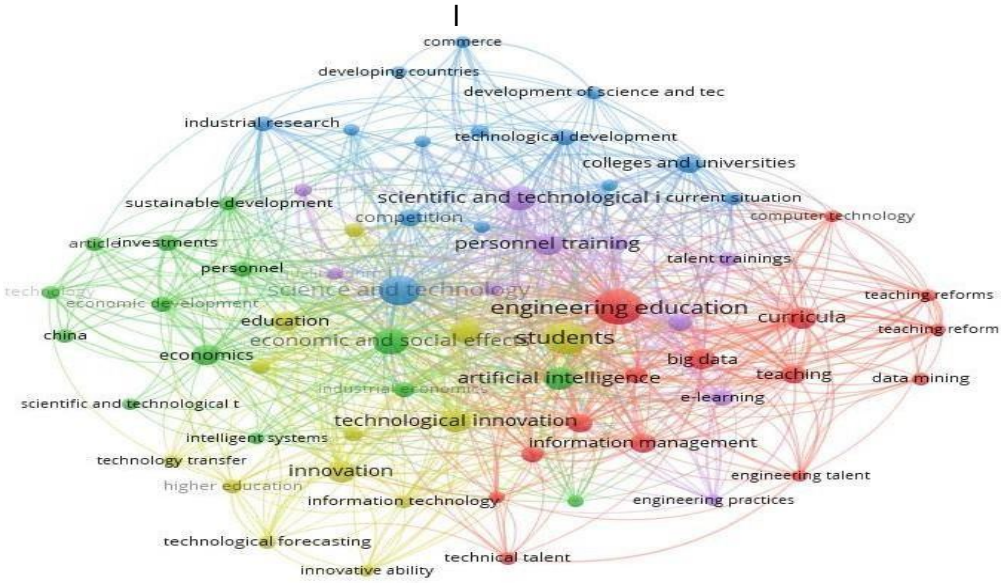
Figure 1. Word map according to Computational Thinking



Source: applied in VOSviewer Version 1.6.18

As can be seen in the previous image, at least four large elements or groups can be linked in the theoretical search using software and bibliometric engines. In the first of them, red education and engineering are linked; The curriculum, the teaching reform, the management of information by teachers, professors, practices and training stand out, which is undoubtedly related to elements linked in the dimension of training to the teaching team.

The second yellow group includes the concepts of innovation, students, technological innovation, education and technological transfer, which are linked to the category of

scientifictechnological skills, while, in the third blue group, the concepts of science and technology,

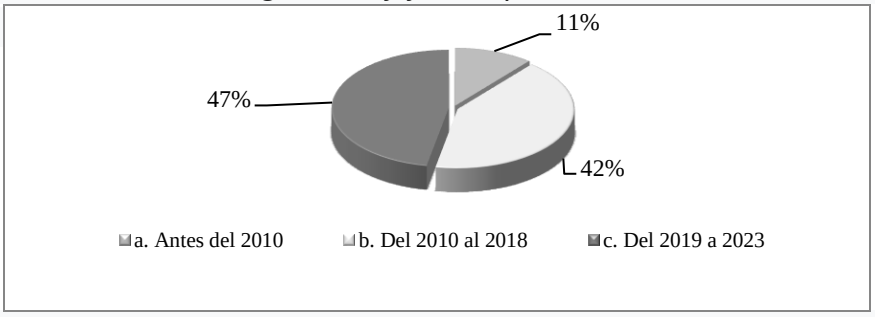
scientific evolution, industry, research, technological advancement and talent trainer are presented that link the category of scientific and technological talent development. In addition, a final green group is presented that links economic development, personal growth and administration that focuses on the categorized aspect of the implementation of techno-science.

2.2.2 Categorical trends

Initially, some generalities are presented that allow the reader to contextualize the topic in terms of the basic profile of the studies addressed, as presented below. In the review of the scientific literature carried out in the educational context, some trends were found in terms of the language in which they are most published, the years of publication, the methodology of the studies, the context to which the studies are most directed, among others, which will be addressed below:

• Category 1. By year of publication

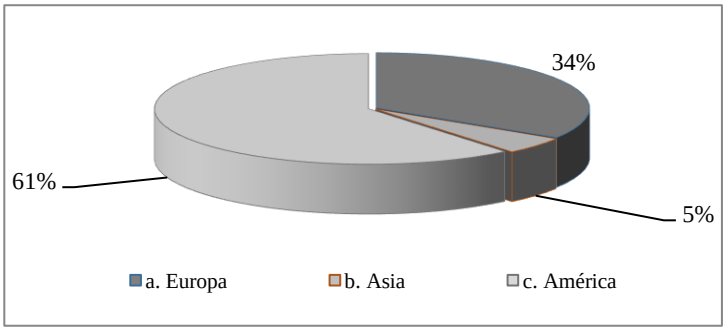
Figure 2. By year of publication



Source: own elaboration

With a Mode (highest repetition value), 47% of the research tracked, 47% are in the range between the end of the decade 2010, until the year 2018 prior to the pandemic; meanwhile, followed by similar participation, 42%, the investigations between the pandemic period and the post-pandemic originating from Covi-19. • Category. Continent/country of origin

Figure 3. Continent/country of origin

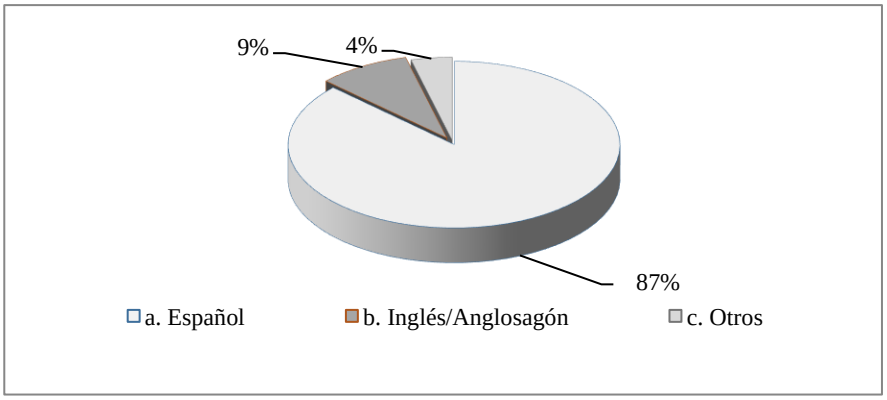


Source: own elaboration

With a marked Mode of 61%, the origin occurs in the American continent with emphasis on Latin America, followed by 34% in Europe, especially in Spain, Greece and England and, finally in Asia, as in China and Singapore.

• Category 2. Publication language

Figure 4. Classification of studies based on their language of publication

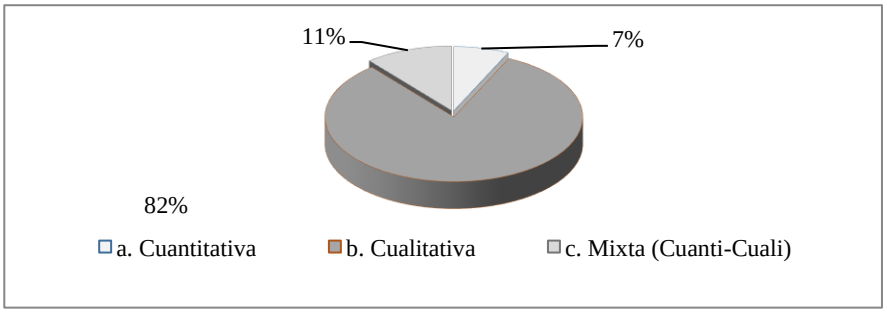


Source: own elaboration

As can be seen in the previous figure, with a mode of 87% of the research tracked, they are due to production and publications in the Spanish language, of which, in order, are South America and Central America, with a greater participation in the countries of Chile, Colombia, Ecuador and Mexico. With low participation, in the Anglo-Saxon language, developed especially in the United States and on the European continent.

• Paradigm and approach

Figure 5. Classification of studies based on the research paradigm

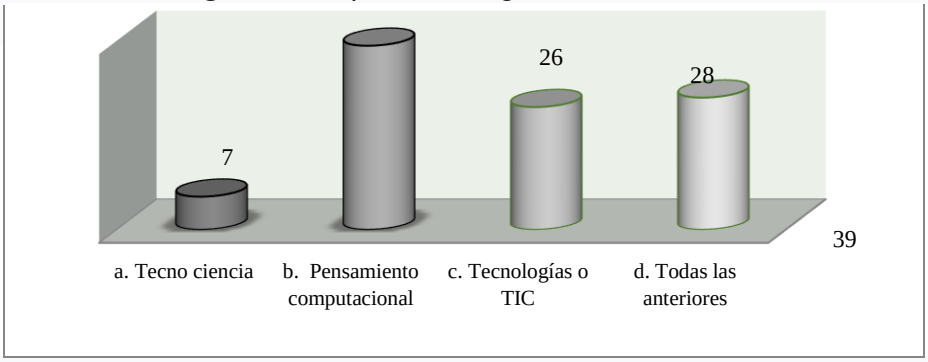


Source: own elaboration

As can be seen in the previous figure, the Mode of 82% prevails, which obeys studies under the interpretive paradigm with a qualitative approach, that is, [30], by incorporating social phenomena, it appropriates the inductive; while both the mixed and quantitative approach investigations only achieved 18% in sum, that is, given the nature of the purely social theme, and with a high level of subjectivity, makes the exploratory and descriptive qualitative paradigms appropriate to said profiles.

• Emphasis categories/variables

Figure 6. Emphasis categories/variables



Source: own elaboration

The studies under the PC category stand out with 39%, however, techno-science and ICT are dimensions of the same PC, so it can be deduced that the total of research is framed within the Fourth Industrial Revolution or Industry 4.0, with emphasis on technological resources.

It is worth highlighting the refereed research, chronologically, in each of the international contexts, starting with the European continent, specifically in Spain, as part of the global trend

in the development of the PC, initiatives have been implemented as shown in the document programming, robotics and computational thinking [31], which presents the current situation of its teaching taking into account current legislation.

This paper presents notable proposals in the university, civil and business field such as Grupo KGBL3, UdiGitalEdu, Programmos, social initiative CLOQQ, Hacking STEM and Make Code of Microsoft, Scolartic, Sociedad Cientifica Informática de España SCIE, Institución Cientifica SEK and platforms such as bMaker, Bitbloq, Diwo dedicated to promoting the development of the PC in Spain with different pedagogical alternatives, focusing on innovation, research, imagination, video game programming and mobile applications from a multidisciplinary and transversal point of view. This report shows a brief overview of the introduction of CT skills in the school curriculum of some European countries at different levels.

The methodology used analyzes the current regulations of the national curriculum, as well as provisions corresponding to the participating autonomous communities. Likewise, it includes actions that have been carried out in Spain by different entities. Methodologically, an anonymous survey was carried out among 351 teachers to collect opinions on pedagogical approaches and resources used in their classes. The results revealed that the majority of respondents consider that a transversal approach is the most appropriate for the infant and primary level. In addition, it was observed that block-based visual languages such as Scratch are widely used (more than 86% of respondents), along with others such as app inventor, HTML and python. In terms of resources, most teachers apply disconnected activities that include physical and card games. Regarding training, the majority train themselves, but some have received training from the Ministry of Education and Vocational Training -MECD- or from the Education Departments of the autonomous communities [31].

In conclusion, programming, robotics and the PC appear in the current Spanish curriculum; several autonomous communities have begun to include relevant content in secondary school

on an optional basis. Companies and government and other non-profit organizations offer free training and resources to teachers in these areas. It is essential that collaborations be established between educational administrations and academia through research to strengthen decision-making in this area.

Regarding the development of CT in countries such as Greece, the study [32], on perceptions, beliefs and attitudes of computer science teachers in public secondary or primary schools, focuses on their views and disposition towards this skill and its integration in education through research whose methodology is based on the theory of reasoned action (TRA) and the technology acceptance model (TAM). The results indicate a high interest in CP and the willingness of participants to engage in professional development programs, although they also show misconceptions and negative attitudes towards its integration into education, suggesting the need for appropriate training approaches and additional discussion to support its effective incorporation.

In summary, the importance of effective teacher training is highlighted as a crucial factor to make the most of the pedagogical potential of CT. The collection of valuable data on the integration of CT in education has provided a solid basis for the design of teacher professional development programs in Greece. However, it is notable that the teachers surveyed have not fully recognized the epistemological nature of CP, limiting it in some of its dimensions, although they did recognize its interdisciplinary nature. This underlines the importance of fully understanding the interdisciplinary nature of computer science associated with PC [32].

On the other hand, many countries have updated their education programs in Europe in recent years to introduce computer science concepts, thus promoting PC. This impulse originates from the European Commission's 2021-2027 digital education action plan "Improving digital skills and competencies for digital transformation". This report analyzes 22 member states of the European Union and eight that do not belong to it in a period between 2016-2021. Systematic

literature review, surveys, online consultation events, case studies, semi-structured interviews and focus groups have been used as methodology and instruments.

The results obtained regarding the integration of PC in the study plans have multiple fundamental reasons. Firstly, it seeks to promote problem solving, logical thinking and programming, in addition to supporting the employability of students; Secondly, it focuses on the development of essential transversal skills such as critical thinking, creativity, collaboration, personal development and analytical skills. It also focuses on promoting ethical use and interaction with new ICTs, stimulating interest in mathematical skills and digital literacy. These European educational approaches include programming/coding, algorithmic thinking, PC, computer science education, and computing education. In primary European education in countries such as Lithuania, Norway and Slovakia, playful and hands-on pedagogical approaches are adopted, where programmable robots and block environments are used to teach computer science concepts; Meanwhile, in secondary school, the emphasis is placed on personalized and project-based learning, highlighting the importance of debugging and learning through error. In addition, it seeks to ensure a broader development of PC skills, promoting gender equity and inclusion through educational initiatives that emphasize the importance of this competence in the digital age and seek to stimulate interest in computing and STEM, especially among girls and boys [33].

The report proposes key recommendations to integrate CT into European education. This includes strengthening understanding of CT as a foundational skill, articulating a coherent strategy across the curriculum, ensuring systematic implementation, and offering supportive policies that promote equity and inclusion. It emphasizes the importance of continuous collaborations and evaluations to improve the quality of computer science education and measure its real impact [34]. On the other hand, it is important to consider the report on programming and algorithms in the English curriculum, which analyzes these two lines

incorporated in the curriculum, examines their importance and summarizes the approach adopted by the National Center for Computing Education (NCCE) [35]. The document presents a vision of programming that goes beyond writing code and encourages the consideration of abstract levels. Additionally, it highlights progression in these areas throughout primary and secondary education, offering additional resources. Pedagogy and professional development are also addressed in this report.

For this study, 34 computer teaching units and Isaac Computer Science topics were reviewed, while the objective of the national curriculum is to prepare students for a world that is increasingly digital, emphasizing reading and writing programs, learning increasingly complex ideas aimed at alternative programming paradigms, object orientation and functional programming. It also focuses on the development of algorithmic skills, decomposing problems, debugging and optimizing solutions. Data representation and PC are key pillars, along with promoting creativity, collaboration and ethics in technology.

The Curriculum for Teaching Computing and other NCCE content categorizes ten aspects focused on different skills: Algorithms, media creation, computer systems, design and development, data and information, effective use of tools, impact of technology, networks, programming and security. This is addressed through four principles that revolve around concepts, plans and patterns, context, ownership transfer, and design, code, and execution perspective.

This study also takes into account an approach of abstraction levels such as task, design, code and execution. The results reveal steps in high-level progression present in the plan and therefore in the national curriculum it covers.

In the American context, and especially in the Latin American Region, it is essential to explore research related to the development of CT in high school students in Chile. A study conducted offers valuable insight in addressing the issue that most efforts to integrate CT into K-12

education focus on visual and block-based tools, prioritizing early grade students [36]. This poses a significant lack in terms of research projects that examine how CP develops in higher school students, who generally do not have early formal preparation to acquire these skills. As a methodology, tests were carried out on the effectiveness of teaching a programming language such as C++ to promote PC in high school students, through an evaluation before and after a voluntary C++ workshop. The results obtained demonstrate a significant improvement in PC after the workshop. However, it is observed that there was a tendency to abandon the workshop by students with lower initial levels of CP. Additionally, 100th graders had lower final grades than 110th and 120th graders. The study concludes that teaching a low-level programming language is beneficial for high school students, although it presents significant barriers to participation.

In the same line of research, in the PC category, the doctoral thesis called Personalized learning scenarios based on the evaluation of the PC for learning programming skills through a blearning and gamification environment, [37] carries out field work at the INACAP university in the Republic of Chile and at the University of Salamanca in Spain, with university students who participate in a hybrid teaching and learning process, b-learning, in which they combine face-to-face classes with documents and virtual learning objects. (OVA), transfers video game techniques to the educational field. He concluded that IT is empowering and enriching; In addition to contributing a lot to educational practices when students perceive them as interesting, helping them understand innovative topics more easily and interact and communicate in their classes; and also ensure its easy development, because it is known that there are many different factors that influence the strengthening of learning, and it shows that the correct and effective use of technologies, although it is not the panacea in the process, does represent a definitive benefit in it.

From another perspective, it is relevant to consider the study, called Technological aids in primary school libraries as pedagogical resources for reading comprehension in students of the

San Juan educational institution, Trujillo, 2019, which is based on the relevance of using strategies linked to the use of ICT as a means to enhance the reading understanding process, from a quantitative, implemented perspective and with a non-experimental structure. It was determined that after implementing the technological strategies, practically 100% of the students made progress in various reading skills such as content learning, among others, which ultimately led to achieving and understanding relevant reading comprehension [38].

Thus, it accelerates the spread of discoveries, studies and knowledge; It enhances the student's interaction with his classmates and with the educational experience by maintaining motivation and reducing geographical distances by quickly transmitting to various people at the same time, regardless of where they are. For this reason, its implementation in school libraries is essential to enhance and perfect the reading understanding process in the classroom.

By incorporating information technologies, [39] addresses his research on assertive communication skills, based on significant learning mediated by ICT with 50-year-old primary school students; This study aims to examine communicative competencies through the theory of meaningful learning, with the municipality of Maicao, La Guajira, as the research setting. From the identified problem, the design and implementation of strategies focused on the study of the use of communication skills related to speaking, listening, reading and writing is carried out, which facilitate their articulation through certain technological instruments.

This is a qualitative paradigm investigation, focused on describing, using an action research methodology, with 23 key informants. Through interviews, the data required to carry out the triangulation method is collected. Limitations are considered with caution, since it can only be stated that the research results are derived from the study intervention or from the evolution (schooling) of the participants. This allows the research to achieve the established objectives.

This shows how the 50th grade boys and girls, through meaningful learning, develop activities in an entertaining way and whose intervention-action triggered a strengthening of the communicative process among the students.

Afterwards, an intervention that includes training with ICT-based modules for problem solving, and finally a final evaluation, concluding that ICT-based modules reduce technological illiteracy, promoting skills and abilities that facilitate the reduction of the social gap.

Research on CP has been a topic of interest internationally, but its development and application in Latin American education still presents a limited panorama in terms of studies and analysis. The study focuses on addressing this research gap by carrying out a systematic review of the literature between 2006 and 2020, with the objective of analyzing how CP has been integrated into primary and secondary education in the Latin American region. The results obtained are divided into two main categories: conceptualizations and integration strategies. The conceptualizations are subcategorized into two approaches, one that considers it as part of computer science and another that perceives it as a methodological tool. Regarding integration strategies, the most common in the region are educational robotics and programming in block languages [40].

The results show the existence of latent needs in the field of research, underlining the importance of carrying out more detailed analyzes to integrate CT into various study plans. Likewise, it highlights the relevance of identifying and documenting resources, especially those unplugged, which were not addressed in this investigation. Furthermore, it highlights the need to continue with research that culminates in the creation of resources for the evaluation of student learning, especially those who benefit in the long term from CT in different disciplines. Another important background on CT in Latin America, which carries out a systematic review on CT as a generic skill for solving problems in different fields of knowledge [41]. Its objective is to understand how it is understood in detail, how it is encouraged in educational environments

and at what educational level it is considered most appropriate to develop it. Its methodology was based on the systematic review of 100 sources in Spanish from the last 5 years. As a result, it was obtained that 40% of the analyzed resources address CT as a generic skill applicable to everyone, especially in solving problems in physics, mathematics, history, culture and music.

It is important to highlight the research document that addresses the problem that teachers do not have the necessary pedagogical and technical skills to develop CT in their students; this research finds as one of the main reasons the lack of formal programs or curricula that provide this possibility [41]. The project aims to identify the level of skills related to CT of future teachers linked to the Universidad la Gran Colombia to generate strategies, teaching orientation and curricular proposals aligned with the Fourth Industrial Revolution. The dominant quantitative approach methodology and the survey are used as a technique to collect information and establish the relationship between study skills and techniques, presenting a conceptual, methodological and statistical analysis. The results obtained relate the components of the PC such as abstraction, decomposition, generalization with the students' study techniques. However, algorithmic thinking presents an unfavorable attitude when designing ordered and sequential schemes to facilitate learning.

It was identified that the inclusion of CP in early training is complex given the lack of professionals trained to teach it. For this reason, it is essential that the University proposes curricular strategies in the study plans for teacher training focused on these skills [41]. From the refereed research in the department of Nariño, Colombia, the doctoral thesis called Didactic model based on B-learning and PC to strengthen mathematical learning in high school students was recently found, it addresses the problem of strengthening learning by using an approach based on B-learning and PC. That is, B-learning, also known as blended learning, combines face-to-face education with online education, taking advantage of the advantages of both

approaches. On the other hand, CT refers to the ability to solve problems logically and systematically, using concepts and techniques from computer science [42].

Finally. From the Asian continent in his text Computational Thinking Education, with a specific focus on PC education [22], whose content corresponds to a group of world-renowned academics and researchers, who are pioneers in research on PC education, under mixed research, interpretive paradigm with qualitative approach, under projective techniques such as observation, interview, focus group and, from the positivist paradigm with holistic approach [43], under survey technique with Likert Scale, he seeks to promote the synergistic learning of science in the classrooms from an early age so that young people go beyond just consuming technology towards problem solving and innovation. Consider CT as a universal competence that young students must acquire. A prominent example of this initiative is "CoolThink@JC" in Hong Kong, which aims to train children and young people in the application of digital creativity through PC education. This program not only involves students, but also incorporates teachers and parents in the process. Its approach seeks to prepare new generations to face future challenges in various fields, promoting comprehensive and collaborative education from an early age.

Conclusions

From the tracing of the various investigations, it is possible to highlight a multivariety in the way of conceiving the methodological designs of the different investigations that, as it was determined throughout the relocation of information, qualitative studies or qualitative paradigm predominated. That is, in some cases the studies were approached from models that, from the epistemological point of view, in their qualitative component, emphasize the need to be interested in the human being, their individuality, in order to know their appreciations, conceptions, in short, their life world, moving away from stereotypical theoretical patterns.

Likewise, epistemologically, due to its philosophical origin, as well as the subjectivity, typical of

qualitative approaches, some research alluded to Hermeneutics, or art of understanding. This means that, through these, an approach to understanding can be achieved in an interpretive manner. Other studies emphasize the relativist, constructivist model that, in the case of educational models, break with the classic stereotypes in which the student was not given a leading role [44].

An important fact that was common in all the refereed investigations was that when defining their type of qualitative research approach or paradigm, they appropriated the NonExperimental design, which tends to privilege the analysis of causality, which implies the use of study categories. Thus, in the case of non-experimental studies, the object of the selected studies, there is no type of impact, on the part of the researcher, on said categories; Therefore, contrary to experimentation, cause-effect analysis is not carried out without any mediation on the causes [45].

Finally, no studies were found that adopted the experimental method, that is, research in which the correlational type is considered, whose purpose is to identify the existence or not of a relational order or level at which the variables are associated in a particular sample or context, that is, in other words, the relationship between two variables is not analyzed.

With respect to the conceptual trends on the subject, for the object of study, the different dimensions of Industry 4.0 were addressed, that is, the PC, ICT, the technological tools that facilitate learning, meditation and play, in the case of gamification.

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