Exploring Educational Horizons: An Analysis of Interdisciplinary Competencies in Education Today

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Abstract

Global education, led by National and International organizations, has evolved towards an approach focused on the training of competent and adaptable individuals for the current labor market. This change has promoted inclusive, equitable and quality education, recognizing its importance in social and human development. In this sense, the purpose of this research was to analyze international, national and local documents in the context of interdisciplinary competencies in Mathematics, Technology and Research, evidencing trends, challenges and practices that guide the continuous improvement of education in the 21st century. The Methodology was qualitative because it was based on an exploration plan that allowed us to understand the phenomena from the perspective of different international, national and local entities according to educational quality in the context of competencies in mathematics, research and Technology. The documentary analysis consisted of a process of information collection and data synthesis, allowing the systematization of the information through the triangulation of the relevant information recorded in the documents, combined with different sources of information. In the triangulation process, interdisciplinary competencies emerge as a category and subcategories that can be applied in areas such as Mathematics, Research and Technology; in addition to strengthening pedagogical work, understanding that the acquisition of skills, abilities and competencies in the school context depend on the joint work of students and pedagogical practice, with teacher training and the skills and competencies of the educator being part of the latter. use appropriate teaching strategies.

Keywords: Competencies, interdisciplinarity, educational quality and pedagogical work.

1. Introduction

Education from the global context has had the presence of organizations such as the OEI (Organization of Ibero-American States for Education, Science and Culture), UNESCO (The United Nations Educational, Scientific and Cultural Organization) and ECLAC (Economic Commission for Latin America and the Caribbean), which have been pioneers in promoting and

improving the quality of education. These institutions have jointly committed to taking on common challenges that education is experiencing worldwide, recognizing the need to have sustainable, inclusive, equitable and quality education as a fundamental part of social and human development.

The new global educational approach has focused on the preparation of competent, efficient, flexible, productive, creative and, above all, capable of facing the challenges of the labor market. In the same vein, global change has been organizing education systems around four fundamental strategic shifts: the role of the state, the school as a business organization, market-oriented school subjects, and flexibility in curricula. This change brought with it an economic rationalism in education, where concern for economic objectives, consideration of the market as a reference and the efficient administration of the educational system became essential components for education.

In order to know in depth the educational context in the era of globalization and in the framework of interdisciplinary competencies, the article entitled: "Exploring Educational Horizons: An Analysis of Interdisciplinary Competencies in Education Today" whose purpose is focused on analyzing international, national and local documents in the context of interdisciplinary competencies in Mathematics, Technology, and Research, highlighting trends, challenges and practices that guide the continuous improvement of education in the twenty-first century.

In this sense, different documents with contributions to educational quality were approached, emphasizing what is proposed by organizations and institutions such as the Economic Commission for Latin America and the Caribbean (ECLAC), the Organization for Economic Cooperation and Development OECD, the Tuning Project for Latin America and the United Nations (UN) through education. especially supporting the 2030 Agenda and the Sustainable Development Goals (SDGs), in particular the fourth goal on educational quality, among others.

On the other hand, an approach was made to the guiding documents of the Colombian Ministry of National Education, constituting the basis for the work in the national and local context of the educational institutions, being able to review and analyze guiding documents of the mandatory and fundamental areas pertinent to the competencies in research, mathematics and technology. Likewise, regulatory documents in the local context, such as the Institutional Educational Project and the Institutional Evaluation Processes.

The commitment to education must be in correspondence with the requirements of the knowledge society, so that the aforementioned entities and the World Bank have worked hard in order to transform educational systems, seeking to make them more efficient and of quality, in this sense Acosta (2008) emphasizes that, "in the 90s the Colombian territory was concerned with the transformation of Culture, economics and politics" (p.3). An education characterized by the preparation of the individual, his efficiency, productivity, creativity, competitiveness and determined by the ability to provide solutions to problems and changes in the market, implying processes of permanent training in the educational field.

This manuscript will present an analysis of international, national, and local documents that will identify trends, challenges, and successful practices that can guide the continuous improvement

of a teacher in the educational field. Finally, the reader will find a range of competencies proposed for the 21st century, which can be merged into different areas of knowledge whose purpose will be to shed light on the paths that can lead to a more effective and relevant education at the basic and secondary education levels

Description of the problem

It is relevant to highlight that the results of the external and internal tests of educational institutions in the context of basic education show shortcomings in the educational system, understanding that, for good academic results, teaching practices must be framed in pedagogical and didactic strategies, configuring these in the pedagogical work of the educator within the educational context. In this sense, it is necessary to understand that for a teacher to be coherent with the needs of the school context, he or she must be immersed in the new educational trends and have a training process in accordance with the requirements of education in the global context, knowing that those skills, abilities and competencies that he or she intends to develop in the student must be appropriated by each teacher in his or her training process.

On the other hand, the transition from basic education to secondary and higher education becomes complex and quite discouraging, being evident in its process, the need to review, analyze and include relevant strategies that contribute to the development of skills and competencies in students of basic education, ensuring that their passage to higher education becomes clear. simple and meaningful, which would significantly influence the determination of better results in terms of their performance in society and their working life.

In today's society, young people require preparation in transversal skills in all areas of knowledge to face the challenges of the labour market. In this sense, it is necessary for individuals to develop skills that allow them to intervene in a coherent way with the problems of their environment, interpret their interrelationships and produce new knowledge in different areas of society. This can only be achieved with adequate and contextualized guidance for the effective development of interdisciplinary competencies in areas such as technology, mathematics and the field of research, which are essential for the twenty-first century.

According to the most urgent needs in the education sector, local contexts emphasize planning according to the requirements of the global context, in this sense, the purpose of educational training is characterized by the training in competencies of its students, in this order of ideas, the Educational Institutions that guide Basic and Secondary Education are based on the orientations of their Magna Carta called Institutional Educational Project, which gives a glimpse of the stakes and objectives that arise from the context of globalization.

It is pertinent to know what the Institutional Educational Project (PEI) refers to, thus, the Ministry of National Education defines it as:

... The navigation chart of the schools and colleges, which specifies, among other aspects, the principles and purposes of the establishment, the teaching and didactic resources available and necessary, the pedagogical strategy, the regulations for teachers and students and the management system (https://www.mineducacion.gov.co/1621/article-79361.html).

In this sense, and in accordance with Decree 1860 of 1994, it reiterates the need for the Educational Institution to fully define and develop the Institutional Educational Project, based on the social, economic and cultural conditions of the context and the needs of the students and their environment, requiring that the IEP be concrete, feasible and assessable. In this way, the Educational Institutions plan a work from the management: Directive, Academic, Community and Administrative/Financial, becoming a challenge for the Educational Community that is aimed at responding to the demands of the Society that is in continuous transformation.

In this regard, the Ministry of Education (2004) seeks to ensure that educational institutions take on a first challenge: "to build identity", with the promotion of environments for coexistence and socialization, seeking teamwork; on the other hand, it is necessary to work hard to improve the quality of education, in order to improve the skills and competencies of students, based on the strengthening of individual talents, taking into account learning styles and on the other hand, the review of the learning results of external tests as a means of knowing the potential of students and verifying opportunities for continuous improvement (p. 8).

It is important to mention that the use of the results of the tests must emphasize the interpretation and understanding of problems, propose solutions and acquire skills to adapt to the changes that arise continuously, seeking that the student projects and enhances his or her competencies based on the previously established purposes and goals. In this way, in the local context, a joint work is carried out from the aforementioned management, it should be noted that management is oriented towards "strategic planning, communication systems and the development of the organizational climate"; academic management refers to "the consolidation and implementation of study plans, of articulation of grade, levels and areas (...)", allowing the use of the results and the pedagogical use of resources (p. 9).

Administrative and financial management referring to "goods, the offer of complementary services and the administration of human resources" and finally, community management that: "promotes participation, prevention, coexistence, inclusion and permanence..." (pp. 9-10). As can be seen, the mechanism of each of the efforts, active participation of the educational community, processes of reflection and proposal of improvement plans, without a doubt, are actions that promote the transformation of education and contribute greatly to educational quality, results that are notorious in the academic performance of students and consequently in labor competitiveness.

It is coherent to mention that before reaching this stage of the student's training, one must travel along paths covered with weaknesses in the managerial, academic, administrative/financial and community spheres, and that each circumstance or incident along the way, are opportunities for improvement that meet the needs, interests and expectations of the student according to the global context. becoming a challenge for teachers, students, parents and local authorities.

From this perspective, it can be seen that Educational Institutions have a commitment to training processes, in this sense, it is necessary that training centers attend to the most urgent needs in the educational field, contributing to provide solutions to the problems and opportunities for improvement of each environment, making an approach and establishment of strategies for the

acquisition of skills and competencies that add to their academic training. Therefore, we highlight the value of adequate guidance for the acquisition of competences in research, mathematics and technology.

2. Theoretical framework

Educational Institutions today must be aware of the new changes that arise at the educational level, in this sense, they must attend to the new challenges, opportunities and requirements of education in the global context, allowing them to appropriate new strategies that provide the acquisition of skills and competencies of students in the process of training at the basic education level.

It is interesting to understand that one of the purposes of education according to Law 115 of 1994, contemplates:

The development of critical, reflective and analytical capacity that strengthens the national scientific and technological progress, oriented with priority to the cultural improvement and quality of life of the population, to participation in the search for alternative solutions to problems and to the social and economic progress of the country (paragraph 9).

It is evident that, to achieve this end, the teacher must focus on establishing strategies for the development of skills and competencies in students. The OECD (2005) refers to competence as the (...) ability of students to analyze, reason and communicate effectively as problems are presented, solved and interpreted in a variety of areas" (p. 2), evidencing that a competent individual is determined by the assertiveness to move in that environment being guided by processes of reflection, interpretation and argumentation.

The OECD in its Project Definition and Selection of Competencies - DeSeCo (1999) aims to promote education through the identification of competencies to face the challenges of the society of the twenty-first century, allowing to understand if young people and adults were indeed prepared for the challenges of life, allowing the establishment of transversal goals for education systems (p.3).

The OECD (2015) emphasizes that one of the conditions for the valuation of competencies has to do with the effective development of these in individuals, not only promoting economic and social development, but also the fact of the great benefits they offer to individual well-being, to greater social and political participation. A second condition is the applicability of the competencies to different contexts, areas of life and the labor market, among others, with transversal competencies being the key competencies that were intended to be identified and given greater emphasis within the DeSeCo Project - Definition and Selection of Competencies (p.p. 6-7).

It is key to highlight that the path to the achievement of competencies must be mediated by processes of theorization and practice of the knowledge acquired, converging attitudes, motivation and values of the learners. And it is here that we can elucidate a fundamental part that

the DeSeCo Project (1999) gives a glimpse of, "reflective mental processes", being evident the thought processes that involve thinking, assimilating and relating them to various situations from the experience of each individual.

In this way, it is important to rescue and show that within any intervention in the academic and/or labor field, several competencies will be required, this is how we want to emphasize those that have to do with the field of research, mathematics and technology, since it is evident that in order to develop a mathematical problem or situation of daily life, It is essential to have skills and abilities that involve reflection, analysis and critical attitude, among others, and likewise, if the interest is to carry out a research process, one must have knowledge, skills and competencies in mathematics and information technologies, as they would be fundamental in the process of building knowledge. elucidating that the competencies in question complement each other and that the result will be more complete and coherent to the needs of the educational context and labor market, as long as the human being takes care to acquire and strengthen them in their daily lives.

At the national level, in Colombia, hard work has been done since the 90s to transform education systems to make them more efficient and of quality. The importance of building institutional identity, improving educational quality and promoting social inclusion and coexistence is highlighted. In this sense, and in accordance with the improvement of academic results, the Ministry of National Education of Colombia has constantly been concerned with supporting the training processes through clear and pertinent guidelines for the compulsory and fundamental areas, aiming that the student is conducive to the acquisition of skills, abilities and competencies consistent with the needs of the global context.

In accordance with the above and based on national guidelines, at the local level, through the institutional navigation chart called PEI - Institutional Educational Project, the MEN (2017) refers to the fact that it must be explicit: (...) the principles and purposes of the establishment, the available and necessary teaching and didactic resources, the pedagogical strategy, the regulations for teachers and students and the management system" (p. 1).

In this way, the educational community, made up of teachers, school directors, parents and the students themselves as participants in the teaching and learning process, must meet the needs of the students, the local, regional and national context, establish goals and actions to be implemented, whose purpose is aimed at improving the conditions of the population through the acquisition of skills and competencies of the learners.

In this order of ideas and knowing that within the educational field there are several determinants of the academic and formative results of students, the Ministry of National Education works from four areas: the Directive, related to strategic planning and organizational climate; the Academic, referring to the planning of the fundamental and mandatory areas; the Administrative and Financial, in charge of the administration of complementary resources and services, and finally, the community, understood from the participation of the educational community, coexistence, inclusion and permanence, among others (MEN, 2004).

In this way, it is interesting to mention that academic results must not only be measurable in

relation to internal or external tests, but that this is a mechanism composed of areas such as the Directive, Academic, Administrative and Financial and Community, of responsibility of the entire Educational Community and the State, allowing to predict and affirm that, If one of these areas is not in balance, results can vary considerably.

Consequently, the country's educational institutions, through guide 34 - Institutional Improvement Guide, referring to Institutional Self-Evaluation and the establishment of improvement plans, allow the evaluation of institutional management from the Directive, Academic, Administrative and Financial and Community management areas, being a determining factor for the establishment of improvement plans in each of the aforementioned management areas.

The guide is organized in three stages MEN (2008): (...) Institutional self-evaluation, the preparation of improvement plans and the permanent monitoring of the development of institutional improvement plans (p. 7). In this sense, the country's educational institutions, in accordance with the needs, interests, expectations and context, promote processes of continuous reflection, self-evaluation, establishment of goals and actions of continuous improvement and timely follow-up to each established action, intervening assertively in the processes of student training.

It is a journey covered with strengths, weaknesses, and struggles, which in the light of what is to be achieved, become opportunities for improvement for the acquisition of new knowledge, new skills, knowledge, skills and competencies that not only nourish the education of the student, but are the nourishment and transformation of the teaching work. results that will be evident in the academic performance of the students and consequently in labor competitiveness.

And it is from this perspective that it is pertinent to emphasize the acquisition of competencies of students from their initial training process, an educational process in basic education consistent with the needs of the local, regional, national and global context, in accordance with the continuous needs and demands of the era of globalization, in this area, the need for the acquisition of competencies in research, mathematics and technology is highlighted, which are a fundamental basis for the development of the human being in various contexts.

It should be noted that in order for there to be an adequate training of students, it is required that the pedagogical work of the educator be coherent with the needs of the student, in this sense Zamora (2014) as cited in Barón (2019) refers to the fact that in every research process the didactic processes that lead to structuring the subjects must be highlighted (p. 6), considering that students with the guidance of the teacher can, within the research process, acquire knowledge in a significant way (p. 24).

In this sense, it is important to highlight the work and guidance of the teacher within the process of acquiring knowledge of the student, as well as to deduce that the results of the students depend on the strategies used by the teacher and for this it is important that the educator has an appropriate training, that he has the appropriate competencies to teach and develop these skills in his students. skills and competencies required to face the global context. In this sense, it is concluded that the teacher must have the required competencies and the appropriate

methodological training for a coherent orientation to the students, being a fundamental determinant for the effective training of the students.

Based on the above, a teacher trained in competencies is prepared to address educational challenges from multiple perspectives, promoting creativity, critical thinking and the resolution of complex problems, among others. In this sense, there are studies that not only favor training in competencies, but also work in an interdisciplinary way, such as the STEAM approach, which refers to the integration of areas of Science, Technology, Engineering, Arts and Mathematics, which arises as a strategy to promote students' interest in science and to develop professional skills for a globalized world. giving greater prominence to the role of the student.

Thus, the work of Cuervo and Reyes (2021) called "Contribution of the STEAM methodology in curricular processes" presents a systematic review of the literature that seeks to identify the contribution of the STEAM methodology in curricular processes; To this end, they formed a corpus 50 document and applied the PRISMA method that allowed them to detect four lines of work, associated with the STEAM theoretical foundation in education, methods and contributions of the STEAM methodology to both curricular interdisciplinarity and teaching competencies.

Undoubtedly, it can be said that STEAM has had a positive impact on the training process, strengthening interdisciplinarity and transdisciplinarity, since it is assumed as a flexible approach, facilitating teachers and students with comprehensive learning that values individuality. However, like any innovation, it requires processes of adaptation and pedagogical renewal to be applied effectively and relevantly in various educational realities.

Objective

Analyze international, national, and local documents in the context of trends, challenges, practices, and interdisciplinary competencies applied in areas such as Mathematics, Technology, and Research, in order to guide the continuous improvement of education in the twenty-first century.

3. Methodology

The structure of the construction of this fabric originates through an exhaustive research of documents that were analyzed with the purpose of knowing the perception of educational quality within the framework of the competencies in research, mathematics and Technology that are being proposed at the Global, National and Local levels.

The approach was qualitative because it was based on an exploration plan that allowed the phenomena to be understood from the perspective of the participants in their natural environment and in relation to the context. (Sampieri & Mendoza, 2018, p. 390). To this end, it is very important that the researcher identifies, becomes familiar with the context where the exploration will take place and interacts with these actors who will be sources of information that will contribute to the understanding and transformation of reality.

On the other hand, the documentary analysis consisted of a process of systematization and synthesis of qualitative data, which allowed the triangulation of narrative documents, combined with different sources of information; therefore, a content analysis or discourse analysis was required (Bisquerra, 2004), since "it constitutes an intellectual support for the accumulation of knowledge, facilitates the approach to the evolution of human talent by offering a conceptual basis" (Sánchez & Ángeles, 2017, p. 224). Therefore, documentary analysis is a tool that gives the researcher the possibility of knowing a topic in depth from a series of documents and in turn systematizing, to later analyze it, confront it and generate conceptual transformations.

In this sense, in this study, 50 documents were analyzed through an analytical-synthetic process, related to the quality of education at the global, national and local levels, emphasizing competencies in Research, Mathematics, Technology, evidencing trends, challenges and practices that constitute the foundation of education in the twenty-first century.

In this documentary analysis study, the following phases were used, according to Hernández and Tobón (2016, p. 403), phases that allowed determining criteria to search, select and organize documentary information:

Phase 1. A search for articles was carried out in Google Scholar, in university repositories and platforms such as Scielo and Redalyc. In addition, the Tuning Project and DeSeCo Project – Definition and Selection of Competencies as an international initiative, UNESCO and United Nations documents, National Pedagogical and Methodological Guidelines - Colombian Ministry of National Education - corresponding to Competencies and standards in Research, Mathematics and Technology were taken into account; documents such as the Institutional Educational Project and Guide 34 (Institutional Self-Evaluation and Improvement Plan), the latter focused on intervention at the local level, were addressed.

Phase 2. Criteria were defined to select the academic articles considered relevant to be used in this study. The criteria suggested were: each selected document should contribute to globalization, to competencies in Research, Mathematics and Technology and its influence on the educational field and have a focus on the quality of education, based on trends, challenges and practices that constitute the foundation of education in the twenty-first century.

Phase 3. Another documentary source was the institutional documents of the Pedagogical and Technological University of Colombia (Institutional Development Plan and Academic Reform – PAE Academic Project of the Bachelor's Degree in Computer Science).

Phase 4. Definition of categories, since the relevant documents for this study were selected.

Phase 5. A final analysis of the documents was carried out through the NVIVO program that allowed reviewing and strengthening learning around competencies in Research, Mathematics and Technology.

4. Discussion, contributions, results

Preparing students with skills for the 21st century is a fundamental concern for international organizations such as UNESCO, OECD and OEI, which work to improve education and the dissemination of knowledge in line with the Sustainable Development Goals (SDGs), especially SDG 4, which promotes quality education. In this context, the OECD highlights the importance of skills such as computational thinking, while the OEI underlines the need for teaching that incorporates research and technology skills, adapting to the demands of an increasingly digitized and innovation-oriented world, including key areas such as mathematics. These competencies encompass communication, logical reasoning, problem solving, critical thinking and technological thinking, design thinking, among others, emerging from national competency standards and aligning with the approaches promoted by government entities.

In the cluster analysis in the Nvivo qualitative analysis program, essential competencies have been identified that include research, problem-solving competencies, design thinking, creative thinking, logical reasoning, systemic thinking, and critical thinking, as well as communicative and technological competencies. Research plays a crucial role in the generation of knowledge, with an emphasis on skills such as question formulation, observation, analysis and communication of results. Integrating these competencies into interdisciplinary areas such as research and mathematics prepares students to apply their knowledge in a practical and effective way, fostering adaptive and meaningful learning that responds to the needs of the 21st century and contributes to the sustainable and equitable development of society. Figure 1 on the analysis of the competencies that are trends today is shown below.
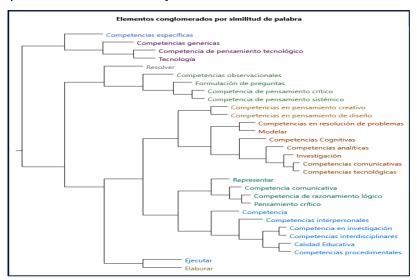

Figure 1. Conglomerate of categories that the study phenomenon yielded

Note: the graph represents some relevant competencies of the 21st century to work in education in an interdisciplinary way

The cluster analysis marked a route of possible competencies that can be developed in an interdisciplinary way in terms of knowledge, skills, attitudes and values that will become increasingly crucial to achieve success both in the workplace and in society. However, the Organization for Economic Cooperation and Development [OECD], (2019) proposes a series of skills in education that can be applied to all areas of knowledge (mathematics, technology, science, Spanish language, natural sciences, social sciences, among others) and are also reflected from the field of research, among them are: 1-) social and emotional competencies; whose purpose is to promote tolerant and kind societies. 2.) Professional, technical and specialized skills; indispensable to satisfy specific professions, applicable and sufficient to assume unknown fields of work. 3-) Basic skills; A high level of proficiency is required in terms of: reading comprehension, mathematical skills and digital skills that facilitate social and work adaptation. At last; 4-) Transversal cognitive and metacognitive competencies; capable of promoting problem solving, critical thinking, complex thinking, creative thinking, learning to learn competence and self-control.

It is important to highlight that the competencies proposed by the OECD for the twenty-first century in Colombia are adapted in areas established by General Education Law 115 of 1994, which have institutional documents created by the Ministry of National Education (MEN), called curricular standards and/or orientations. In this way, this research aims to make visible in detail the competencies reflected in areas such as Technology and Mathematics, which should be known and applied by children and young people at the primary school, basic secondary and middle school levels. Below are some basic and interdisciplinary competencies necessary for the comprehensive development of students in the twenty-first century, among them are:

Competencies through computational thinking

One of the fundamental competencies in which every person must function in the digital society is computational thinking, According to Alsina and Acosta (2022) it is important to indicate that computational thinking arises in 1980 by Papert, in the book Challenge to the Mind, the author indicates that, "... The construction of new learning is more effective when the learner commits to the elaboration, by his own means, of a tangible object with some significant representation, which is known as "learning by doing" (pp.9-10).

In the same vein, Wing (2006) cited by Alsina and Acosta (2022) points out that it is "a fundamental skill for everyone, not just for computer scientists. For reading, writing and arithmetic, computational thinking should be promoted in the analytical capacity of each child" (p.10).

Computational thinking, initially conceptualized by Papert and later expanded by Wing, has proven to be a key tool for technology education. Papert stresses the importance of "learning by doing," suggesting that learning is enhanced when students actively participate in the creation of tangible objects with personal meanings. Whereas, Wing broadens the scope of computational

thinking, emphasizing its universal relevance and crucial role in developing analytical skills from an early age.

According to Barragán (2023), computational thinking promotes the skills of: solving problems, breaking down a problem into easier to understand parts, encouraging logical reasoning, recognition of numerical patterns or logical sequences, working on abstraction from the identification of important parts of a problem and ignoring the less relevant, creating algorithms through the list of steps to solve a problem, among others. By integrating these skills into the academic curriculum, students will be prepared to face challenges in an increasingly digitized and technological world.

Critical thinking skills

Another indispensable skill in today's world is critical thinking, its origin is not recent, as it dates back to ancient Greece with Plato, Socrates and Aristotle. From a modern perspective, it is "defined as an essential ability to analyze, argue and create solutions based on internal reflection, it is considered one of the pillar competencies of education" (UNESCO, 1997 cited by Tapia and Castañeda 2022, p. 46). To foster critical thinking in education, it is essential to implement strategies that promote analytical and assessment skills in students. These strategies include encouraging problem-based learning, asking open-ended questions that stimulate detailed and justified answers, organizing debates for students to argue their points of view, presenting complex problems that require in-depth analysis, teaching how to evaluate the reliability of information sources, using games that require strategy and logic, analyzing case studies, and encouraging reflection on one's own thought process. Integrating these strategies into the curriculum and daily activities prepares students to meet the challenges of today's world.

Likewise, Ortega and Gil (2020) cited by Tapia and Castañeda (2022), state that in order to have social progress, it is imperative to cultivate critical thinking skills and the ability for autonomous reasoning in students. This in order to train students so that they can identify, analyze and evaluate information effectively. Thus, these skills are not only fundamental for their academic development, they generate cognitive activities related to reason, but they also help the future to enter the labor market.

Technology thinking skills

With respect to the rapid evolution of technology and its growing integration into the different areas of life, the competence of technological thinking stands out, Álvarez et al, (2005) cited by Villota et al., (2019) express that, "in the learning process, particularly in the area of technology, "there are few studies where the student uses, elements such as: autonomous, critical work and the use of strategies that facilitate the appropriation of technological thinking" (p.177). So, to address this lack, it is crucial to implement educational methodologies that promote the integral development of technological thinking. This involves fostering skills such as problem-solving, collaborative work, and innovation from an early age. In addition, the incorporation of practical projects and the use of digital tools in the classroom can facilitate the appropriation of these concepts, preparing students to face technological challenges critically and autonomously.

On the other hand, technological thinking competence is associated with technology that "... comes from the Greek techne where it is called art" (Rueda 2015 Cited by Villota et al., 2019, p.179). In this way, and according to the Curricular Guidelines for the area of Technology, it refers to the set of knowledge and skills that allow people to transform their environment to satisfy needs and desires. This includes the creation and use of tools, machines and systems, as well as the evaluation of their social, cultural and environmental impact, promoting critical and ethical thinking in their application.

It is important to highlight Cárdenas (2023), who allows conceptualizing technology education through several key attributes, aimed at guiding training towards the development of technological thinking, among which are: 1-) Analysis-Synthesis: involves breaking down a problem or system into its basic components (analysis) and then bringing those components together to understand the whole (synthesis). For example, when designing a new mobile app, you first analyze its individual features and then integrate them to create a complete solution. 2-). Analogy/Contrast: uses comparisons to understand new concepts from known ones (analogy) and highlights the differences between elements (contrast). For example, comparing the operation of a computer network with the human nervous system to explain its operation. 3-) Cause/Effect: Examines the causal relationships between events or actions. For example, understanding how an improvement in Google's search algorithm (cause) can result in faster and more accurate searches (effect).4-) Mental System: It consists of visualizing an entire system and how its parts interact. For example, imagine how all the components of an electric car work together to provide efficient transportation.5-) Weighting: evaluate different options and their consequences before making a decision. For example, consider the pros and cons of different materials to build a bridge. 6-) Project Mindset: It focuses on planning and designing projects, anticipating the necessary steps to achieve a goal. For example, planning all phases of development of new software from the initial idea to its launch. 7-) Problem Solving: Focus on identifying and solving problems effectively. For example, finding an innovative solution to reduce energy consumption in a factory. 8-) Rationality: Apply logic and reasoning to make informed decisions. For example, using data and statistical analysis to improve the efficiency of a manufacturing process. 9-) Incorporation of Knowledge: Use scientific, technical, ethical, aesthetic, ecological and socio-historical knowledge when necessary. For example, designing a product that is not only functional and aesthetically pleasing, but also eco-friendly and socially responsible.

Technological thinking complements computational thinking by breaking down complex problems, identifying patterns and cause-and-effect relationships, and planning projects logically and effectively. By integrating scientific, technical, ethical, and socio-historical knowledge, it fosters the creation of innovative and responsible solutions. This prepares students to face technological challenges critically, autonomously, and ethically in a digitalized society

Systemic Competence

In the realm of technology, systems thinking stands out as an essential skill. This capability allows individuals to understand and analyze how the different components of a system interact, from hardware and software to processes and users. In the same vein, Ruiz (2013) states that:

Systems Thinking is a way of seeing the world; a way of talking about reality; an observation and problem-solving tool. Within the numerous definitions that exist, the concept of learning can be abstracted: Systems Thinking can be seen as learning how to handle the complexity of situations (p.5)

Systems thinking is useful for addressing complex and dynamic problems, as it allows multiple variables and perspectives to be considered at the same time, which can lead to more effective and sustainable solutions. Thus, Ruiz (2013) exposes three important characteristics of systems thinking: 1-) Self-organization processes: students could design a project management system for group work. To do this, they can use technological tools to assign tasks, set deadlines and coordinate efforts autonomously, demonstrating how a system can organize itself to achieve a common goal. 2-) Understanding of how systems work: initially you can study the operation of an operating system of a computer or mobile device. Next, students can observe and analyze the operating system. Then, it is possible to understand how the components of the software interact (kernel, file manager, user interface, among others), in this way the study artifact will be allowed to function correctly. 3-) Effects of the whole on the parts and vice versa: showing how artificial intelligence algorithms interact with large data sets to perform specific tasks. Also, how a change in the dataset can affect the performance of the algorithm, and how improving the performance of the algorithm can have an impact on the efficiency of the entire system.

In the words of Castro and Belkys (2021), "systems thinking perceives reality as one, made up of elements that cannot be conceived separately but through their interrelation" (p.9). In this sense, the systems approach considers that these components cannot be understood in isolation, but must be seen in relation to each other in order to fully understand how the system works as a whole. Also, UNESCO (2016) cited by Guzmán and Castro (2021), states that, "technology, in addition, occupies an estimable place for the development of analysis and systemic thinking since it facilitates the study from various perspectives and the development of fundamental actions" (P.140)

Design skills

Next, we will talk about the Design Thinking competence or also called Design Thinking, which is considered a creative and user-centered approach to solve complex problems and develop innovative solutions, as stated by Uribe (2021) who considers that, ... "it is a strategy for the definition of innovative solutions to situations, questions or conflicts" (p.6). This strategy is based on the incorporation of ideas, the consideration of diverse points of view and the breaking of paradigms to achieve specific objectives.

On the other hand, design thinking has 5 phases including: 1-) Empathy: which understands the needs and problems of students. 2-) Definition: It is responsible for clearly delimiting the problem that is faced. 3-) Ideation: allows the release of creativity and generates ideas without restrictions. 4-) Prototyping and evaluation: creates tangible representations of the ideas and finally tests and validates the proposed solutions.

Communication Competencies

Roig et al. (2005) define communicative competence as the ability to transmit messages in a clear and understandable way, avoiding misinterpretations. This allows students to structure their answers following a narrative scheme, which is linked to effective communication competence from the perspective of mathematics, contributing to a more solid and effective learning. To develop this communicative competence, it is essential that students acquire the ability to express themselves clearly and precisely, avoiding misunderstandings in the transmission of their messages.

It is also important that they can structure their answers in a coherent way, following a narrative order that facilitates understanding by their interlocutors. This skill is not only relevant in the field of mathematics, but also contributes to more robust learning in other areas of knowledge. On the other hand, Bautista (2020) refers to communicative competence as the ability to communicate effectively in various situations and contexts.

In the context of competency-based education, this implies the ability to convey messages in a clear and understandable way, avoiding misinterpretations. In the specific case of the text provided, the importance of students being able to structure their answers following a narrative scheme is highlighted, which is linked to effective communication competence from the perspective of mathematics. In addition, the increasingly urgent need to develop the competence of "effective communication" in the mathematical field is mentioned, since the ability to explain and communicate contributes to more solid and meaningful learning.

Proficiency in logical reasoning

Mathematical logical thinking encompasses the ability of people to perform reasoning with technical criteria, perform arithmetic operations, classify, abstract, understand numbers and establish relationships between different objects. In addition, it involves the interpretation of notions with logic, such as grouping, ordering, counting, and analysis of spatial and temporal aspects (Tares & Fernández, 2022). The early development of mathematical logical thinking is crucial for children's academic and professional futures, as it allows them to understand mathematical concepts and solve everyday problems logically.

The diversity of perspectives on this skill underscores the importance of adapting teaching strategies to students' individual needs, promoting an inclusive approach that enhances their development regardless of their learning styles. This competence is not only fundamental for the mastery of mathematical sciences, but also contributes to the development of cognitive skills and critical reasoning in general.

Likewise, project-based learning not only promotes the development of mathematical competence, but also strengthens students' logical reasoning. When tackling a project, students must apply logical reasoning to solve mathematical problems, make evidence-based decisions, and understand the relationships between different mathematical concepts (Zagirre et al, 2020). The process of solving math challenges within the context of a project fosters the ability to think coherently and sequentially, identify patterns, formulate hypotheses, and reach conclusions

based on rules and principles. In this way, project-based learning not only meets curricular objectives, but also contributes significantly to the development of students' logical reasoning, thereby strengthening their ability to apply mathematical knowledge effectively in real-world situations.

Problem-solving proficiency

According to Patiño et al,(2021) problem solving is the process that involves not only the application of mathematical operations, but also the analysis and understanding of a situation. The importance of going beyond the resolution of routine exercises is highlighted, promoting an approach that fosters the understanding and application of strategies to address real problem situations.

In this sense, it is essential that students develop cognitive skills that allow them not only to find solutions to specific problems, but also to adapt and transfer their knowledge to diverse contexts. Problem solving in mathematics not only strengthens students' logical and analytical abilities, but also gives them the opportunity to face challenges that stimulate their creativity and critical thinking. It is necessary to foster an educational environment that fosters exploration, constructive error, and collaboration among peers as fundamental pillars for the development of solid and meaningful mathematical competencies.

In addition, mathematical problem-solving is not only limited to calculation and obtaining correct answers, but also involves a critical reasoning process that stimulates reflective thinking and informed decision-making. Students who face mathematical challenges develop skills to identify patterns, formulate hypotheses, and validate arguments, which prepares them not only for academic situations, but also to face everyday challenges with an analytical and proactive mindset. Problem-solving thus becomes a powerful tool to enhance meaningful learning and students' intellectual autonomy.

Research skills

Restrepo (2003) mentions the role of research, in this case formative research, in relation to learning and the generation of knowledge, referring to the "expository" teaching strategy, which is focused on the teacher and the content and a learning strategy, cataloged by "the discovery and construction of knowledge", being evident the prominence that should be given to the student, allowing the activation of cognitive processes and ensuring that the student acquires skills to search, compare situations, inquire, collect data, organize and interpret information, argue and enunciate solutions (p.197). The author clearly shows that the most appropriate strategy should be focused on teaching, being the most coherent means for training in research skills, being propitious the transformation of pedagogical practices to meet the needs, expectations of the student and current context.

Types of research competencies

The Tuning Project (2003) takes a deeper look at the structure and contents taught in European Universities, referring to two types of competences that support the research process in a transversal way:

Generic competencies

They refer to the ability to analyse and synthesize, general knowledge, the student's ability to self-learn, cooperation, communication, leadership and the ability to organise and plan, highlighting the need to put into practice technical skills, carrying out more complex writing exercises, reading, summarizing and making constructive criticism, carrying out fieldwork and putting into practice the knowledge acquired.

Specific competencies

They are related to the theoretical and practical skills and knowledge of each area of study (p.256). In this perspective, it is essential to focus on the needs of the individual, understanding through the use of different methods, techniques and learning strategies, the correct development of skills and competencies will be determined from their initial training process, being the basis for the acquisition of coherent knowledge for performance in the educational, social, professional and labor fields. On the other hand, the author Castillo (2011) lists eight (8) competencies required in research and their characterization:

Cognitive competencies

According to Castillo, 2010, as cited by Castillo, 2011 corresponds to "the capacity for the structuring and self-mastery of each of the cognitive and intellectual processes that leads to the construction of thinking skills and in turn to various research alternatives" such as: a-) Formulation of questions: referring to the researcher's ability to pose questions, use different techniques, instruments and tools. b-) Observational competencies: referring to the capacity for observation and recording that the researcher must have. c-) Procedural competencies: it has to do with the effective use of the research process and the skill of the researcher in the systematization process. d-) Analytical competencies: related to the researcher's ability to organize and make sense of qualitative and quantitative data and categorization with respect to the expected purpose or objective. e-) Communicative skills: responds to the writing, final report, dissemination and mastery of the process and impact. f-) Technological competencies: "are related to the ability to select and manage data collection techniques through the use of computer packages for data analysis and for the presentation of results" (p. 7). g-). Interpersonal Competencies: it has to do with the researcher's ability to work in a team, rescuing their ability according to Castillo, 2010, as cited by Castillo, 2011 to "live and think in society". (p.7)

The author clearly shows us the competencies that a researcher must acquire during his training process, in this order of ideas, it is necessary to determine the strategies to strengthen the skills of the learner and in this way, the entry into the different cycles, levels or degrees of education are the complement and consolidation of their skills and competencies acquired in the educational process.

Creative Thinking

Another skill for today's world, and one that is essential to the life of every human being, is creative thinking. In the opinion of Hernández, et al., (2018), "creative thinking allows the search for alternatives and opportunities; it can be understood as the ability to think, imagine and act

differently" (p.8) In the same way, creative thinking does not follow a logical, orderly and systematic sequence; rather, it goes down an initially uncertain and disorderly path. It should be noted that it is characterized by generating a large number of ideas that at first may seem absurd. Often, steps are taken that seemingly lead to no specific destination; especially at the beginning, chaos and uncertainty reign. However, it is important to understand that what has been described above is part of the process and that, in the end, it culminates in a phase of clarity and focus. According to Hernández, et al., (2018), the dominance of this competence

it is closely related to the other types of thinking: reflective, analogical, analytical, and systemic; as well as with the ability to observe, to establish relationships with problem solving and decision-making, and with an entrepreneurial spirit, creativity, innovation, flexibility and openness to other points of view, to mention just a few traits (p.9)

Thus, the ability to think creatively is the mental process that leads to the search and discovery of new and original solutions that could be applied in any area of the curriculum.

On the other hand, (UNESCO, 2017) states that it is necessary to "guarantee relevant skills for the world of work. It considers the importance of acquiring skills for work performance such as: problem solving, thinking critically and creatively, collaborative work, communication skills and conflict resolution" (p.52). In the same way, (García, 2020; Uriarte, 2018) mention that Finland is one of the countries with the best performance in the ranking of the Programme for International Assessment (PISA). Since, in its educational policy, it gives great importance to the development of future skills for students, such as creative thinking, critical thinking, entrepreneurship and the use of technology.

Ministry of Education, Republic of Peru (2006), presents some characteristics that can be present in creative thinking: 1-) Originality: Originality is the most important characteristic that defines a creative person, allowing him to produce new and unique responses in his context. 2-) Flexibility of thought: Flexibility is the ability to adapt to circumstances and consider different opinions and approaches to find different solutions. A flexible student can appreciate the global context of a problem and generate multiple alternative solutions, contrasting with mental rigidity, which rejects other opinions and clings to dogmatic ideas. 3-) Organization: organization is an essential characteristic of the creative person, who strives to integrate various elements of a situation to give it structure and understanding. 4-) Divergence: This skill can be developed through activities such as organizing disordered points or elaborating a text based on key words. Likewise, the Ministry of Education, Republic of Peru (2006) considers;

Other additional characteristics of creative behavior are related to depth of thought, sensitivity to problems, curiosity, self-esteem and high self-concept, high motivation for achievement or accomplishment and greater persistence or tenacity among the most important, which will be exemplified in the chapter corresponding to activities (p.12)

These combined skills prepare students to meet the challenges of today's world with adaptability and effectiveness.

5. Conclusions

Education in the 21st century must focus on developing transversal and specific competencies that prepare students to face complex and dynamic challenges. Competencies such as computational thinking, critical thinking, technological thinking, and systems thinking are critical to fostering analytical skills, problem-solving, creativity, and effective communication. These competencies are not only relevant to the technological, mathematical or research fields, but are also applicable to all disciplines, promoting a holistic education that empowers students to be informed, innovative and ethical citizens. By incorporating these competencies into the educational curriculum, a solid and adaptable training that responds to the demands of the twenty-first century is ensured.

The analysis of competencies needed for the twenty-first century highlights the importance of an interdisciplinary education that combines knowledge, skills, attitudes and values essential for success in work and social life. The competences proposed by the OECD, which include social and emotional, professional and technical skills, basic and cognitive competences, are crucial to form individuals capable of adapting and thriving in an ever-changing world. The adaptation of these competencies in the Colombian context, aligned with the General Education Law and the documents of the Ministry of National Education, underscores the need to integrate these skills in all areas of knowledge from primary to secondary and secondary education, ensuring optimal comprehensive development in students.

WORKS CITED

Acosta Jiménez, W. A. (2008). The New Global Educational Order and the Commodification of Public Schools in Bogotá 1990 – 2004. 1-30.

Alsina, Á., & Acosta, Y. (2022). Connecting children's math education and computational thinking: learning repetition patterns with the Cubetto programmable educational robot. Educational Innovations, Vol. 24 (No. 37). Retrieved from https://www.scielo.sa.cr/pdf/rie/v24n37/2215-4132-rie-24-37-133.pdf

Bautista, C. (2020). Development of the communication process in teaching and learning. Revista Q, 11, 148. Retrieved from https://repository.upb.edu.co/bitstream/handle/20.500.11912/8111/Desarrollo%20del%20proceso%20de%20comunicaci%C3%B3n.pdf?sequence=1&isAllowed=y.

Barragán, A. (2023). Computational thinking and programming in the training of students from an early age. Revista Educación, Vol.43(No.2), 1-18. Retrieved from https://www.scielo.sa.cr/pdf/edu/v47n2/2215-2644-edu-47-02-00775.pdf

Barón Pinto, L. (2019). Methodological training for the development of research competencies in teachers of the Basic and Secondary Education research subject. Doctoral Thesis, Metropolitan University of Education, Science and Technology.

Cárdenas, E. (2023). Assessment of the attributes of Technological Thinking in a sample of students in the area of Technology and Computer Science. Retrieved from https://dialnet.unirioja.es/descarga/articulo/4560537.pdf

Castillo Vallejo, S. (2011). Evaluation of research competencies. XII Inter-American Conference on Mathematics Education (pp. 1-12). Recife - Brazil: Inter-American Committee on Mathematics Education.

Castro, S., & Belkys, G. (2021). Educational policies based on systems thinking and knowledge management. Educare, vol. 25(no. 1), 31-65. Retrieved from http://portal.amelica.org/ameli/journal/375/3752262002/html/

ECLAC, (2018). Obtained of https://www.cedhnl.org.mx/bs/vih/secciones/planes-y-Programs/Agenda-2030-y-los-ODS.pdf

Congress of the Republic (1994). General Education Law – Law 115 of 1994. Colombia. https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=292

National Council for Economic and Social Policy [CONPES]. (2020). CONPES Document 3988 of 2020 of 1995: Cities and Citizenship: The Urban Policy of El Salto Social. Bogotá (Colombia)

Cuervo, D. A. C., & Reyes, R. A. G. (2021). Contribution of the Steam methodology in curricular processes. Revista Boletín Redipe, 10(8), 279-302. https://revista.redipe.org/index.php/1/article/view/1405

Delgado, C. (2022). Didactic strategies to strengthen creative thinking in the classroom. A meta-analytic study. Innova Education Magazine, Vol.4(No.1), 52 - 64. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=8152451

Self-evaluation guide for institutional improvement. Educational Revolution Colombia Learns. Ministry of National Education. 2004. P. 1-56 https://oldpage.palmira.gov.co/attachments/article/3393/GUIA%20MANUAL%20AUTOEVALUACION%20INSTITUCIONAL.pdf

Self-evaluation guide for institutional improvement. Educational Revolution Colombia Learns. Ministry of Education National. 2004. P. 1-56 https://oldpage.palmira.gov.co/attachments/article/3393/GUIA%20MANUAL%20AUTOEVALUACION%20INSTITUCIONAL.pdf

Guzmán, B., & Castro, S. (2021). Educational innovations and educational technology at UPEL-IPC. Horizontes, Vol.5(No. 17), 133 -155. Retrieved from http://www.scielo.org.bo/pdf/hrce/v5n17/2616-7964-hrce-5-17-136.pdf

Hernández, J., Jiménez, Y., & Rodríguez, E. (2018). Development of creative and practical thinking skills to start a business plan: design of learning evidence. RIDE, Vol.9(no.17), 1-29. Retrieved from https://www.scielo.org.mx/pdf/ride/v9n17/2007-7467-ride-9-17-314.pdf

Hernández-Sampieri, R. & Mendoza, C (2018). Research methodology. The quantitative, qualitative and mixed routes, Mexico City, Mexico: Editorial Mc Graw Hill Education.

Izagirre, A., Caño, L., & Arguiñano, A. (2020). Mathematical competence in Primary Education through project-based learning. 261. Retrieved from https://www.scielo.org.mx/pdf/edumat/v32n3/1665-5826-ed-32-03-241.pdf

Pedagogical and Technological University of Colombia (UPTC). The Strategic Development Plan 2019-2030 Agreement 049 of 2021. Pp. 1-33.

MEN, R. d. (2006). Guide for the development of creative thinking. Government of Peru. Retrieved from https://www.academia.edu/33262811/GU%C3%8DA_PARA_EL_DESARROLLO_DEL_GU%C3%8DA_PARA_EL_DESARROLLO_DEL_PENSAMIENTO_CREATIVO_PENSAMIENTO_CREATIVO

OECD (2005) Organization for Economic Cooperation and Development. The definition and selection of key competencies. Executive summary. Translated with funding from the United States Agency for International Development (USAID). https://www.deseco.ch/bfs/deseco/en/index/03/02.parsys.78532.downloadList.94248.DownloadFile.tmp/2005.dscexecutivesummary.sp.pdf

[OECD], O. p. (2019). OECD Outlook on Science, Technology and Innovation 2021. (I. 978-84-680-5755-2, Ed.) Fundación Santillana, 258. Retrieved from https://www.oecd.org/skills/OECD-skills-strategy-2019-ES.pdf

OEI (2021). Retrieved from https:// www.segib.org/informeCODEI/assets/Cap01.03_La_OEI.pdf UNESCO. (2019). Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000371024

Patiño, K., Prada, R., & Hernández, C. (2021). THE RESOLUTION OF MATHEMATICAL PROBLEMS AND THE FACTORS THAT INTERVENE IN THEIR TEACHING AND LEARNING. Boletín Redipe, 13. Retrieved from https://dialnet.unirioja.es/descarga/articulo/8114577.pdf

Tuning Project. (2003). Tuning Educatonal Structures in Europe. Final Report Phase One, University of Deusto, Bilbao

Restrepo Gómez, B. (May 2003). Formative Research and Productive Research of Knowledge at the University. (U. C. Bogotá, Ed.) Nomads(18), 195-202.

Roig-Vila, R., Martínez, A., & Buades, P. (2019). Research and Innovation Networks in University Teaching. Volume 2019. In Redes de investigación e innovación en docencia universitaria (p. 20). Retrieved from

https://rua.ua.es/dspace/bitstream/10045/99055/1/Redes-Investigacion-Innovacion-Docencia-Universitaria-2019-01.pdf

Tobón, Sergio (2005). Competency-based training. Complex thinking, curricular design and didactics. Complutense University of Madrid. P. 286.

UNESCO. (2021).https://eduteka.icesi.edu.co/pdfdir/unesco-reimaginar-juntos-nuestros-futuros-- un-nuevo-contrato-social-2021-completo-espanhol.pdf

UNESCO. (2023). Retrieved from: https://unesdoc.unesco.org/ark:/48223/pf0000382765_spa

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canva.com/design/DAGD5b4A0tU/pmBl3JIVExIK9XDeCVk-2g/view?utm_content=DAGD5b4A0tU&utm_campaign=designshare&utm_medium=link&utm_source=editor