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# Digital and environmental competences for sustainability in Latin America: a view from educational research

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*Abstract*

This research with a qualitative bibliometric approach, sought to analyze aducational research in Latin America from digital to environmental skills to contribute to sustainability as an alternative to mitigate the impacts of climate change. This research allowed us to answer some uncertainties in research and educational processes due to accelerated digital and ecosystem transformation such as how do digital and environmental competences from educational research contribute to sustainability?.

The objective was to analyse the concurrence between educational research and digital and environmental skills from sustainability in Latin America in order to interpret the contributions to climate change mitigation.

The results allow us to analize that climate change affect the most vulnerable communities in the región and this new challenges to promote the development of environmental skills in an

interdisciplinary way to acquire scientific knowledge and critical, reflexive and systemic thinking skills supported by and environmental rationality which in this digital age is an opportunity to empower education environements.

Key words: Climate change, digital competences. Environmental competences, education, research, sustainability.

**Introduction**

Conceptual framework development

The development of this research investigated the conceptual references of the keywords and developed the categories of analysis mentioned, accompanied by the approach of the contextual framework; In this way the results are presented in parallel, as follows:

Climate change:

Defined in the United Nations Framework Convention of 1992, as climate change attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that adds to the natural variability of climate observed during constant comparable periods of time, this indicates that there has been statistical traceability that allowed evidence of the presence of this phenomenon of anthropocentric origin (P.4). The effects of this phenomenon put at risk the life of the planet and all bio-ecosystem processes.

Environmental competences

It is important to begin by noting that this concept emerges with the interest of developing the educational process not from the contents, but from the development of skills of students and society, the latter, because the purposes have also been adopted by the labor system. Competencies are qualities that in addition to developing, must be demonstrated and the task of education is to accompany the student for the development and empowerment of skills. The competences are accompanied by knowledge, understanding, analysis and aptitude, which give rise to skills, abilities to reach better efficiency in knowledge and research in everyday life. José Jimeno Sacristán (2008) However, competencies are the means for the development of the cultural, social and contextual curriculum, dialogue and dialogue, because education and research must overcome physical limits to address the problems of society and the environment and even more, in this century that is mediated by the benefits of big data.

Environmental Competencies-CA

They have their origin from the Belgrade Charter of 1975, based on environmental education (EA), which was designed for 48 years to address the crises, change and environmental variability that was

already looming. The development of CA from AD was designed from three actions: (1) raise awareness; (2) acquire the knowledge, values, attitudes, commitments and skills, and (3) create behavior towards the environment, which made training for action necessary; But traditional education has only focused on the first two, without transitioning to a human culture for sustainability and conservation causing harmful effects that have given way to climate change. (William Manuel Mora-Penagos. 2022) In short, the CA, are the skills achieved from knowledge, analysis and understanding for the development of a culture that empowers decision-making and positive human actions with the environment.

Digital skills

Considered as the set of skills, knowledge and attitudes they possess towards ICT. (Gonzalez, 1999; Ruiz, 2010; Esteve and Gisbert, 2013) cited by Flor Edith Chávez et al (2016). UNESCO (2028) adds it as those that enable the use of digital devices, use of communication and knowledge applications, networks to access and manage information, create and share digital content, communicate, collaborate and solve social problems and in context. For the education system it has become a challenge and governments are making efforts to ensure that the adult population adopts them quickly. On the other hand, a tension has arisen in education due to the rapid openness and need for these, articulated with the fundamental cognitive and non-cognitive competencies for life and work in a connected world, joins the above, the tendency to introduce computational thinking throughout the curriculum in an effort to help students understand the logic by which systems and applications of large scale.

Education

It has been considered as the first process of communication and human understanding, and has its origin at the same time as man, it occurs from particular or collective interests around an idea, theme or objective. This process is accompanied by language, skills, communication, understanding, aptitude and culture, through it knowledge is advanced for the solution of particular situations, in this regard Orduz Marcela (2020), comments that:

"Education has no borders, nor limits in the life project of human beings, these are marked by the subject and sometimes determined by the socioeconomic dynamics of the world. In this dynamic, there is a tangible alliance between education and culture, which enhance the development of the mind, knowledge and provides an individual way of thinking to each subject, as well as perceiving and adopting a desire for the future and a way to satisfy human needs. Education has allowed progress in human development, however, there are some constraints such as social and environmental. (Q14)

Research

Valle, Augusta et al (2022) comment that research is a process of inquiry that allows us to approach the understanding of a phenomenon based on questions, fundamental to create new knowledge in a certain epistemological discipline. It begins by asking a series of questions and then carrying out a systematic process of obtaining and analyzing information. Marín, Duván (2019) defines it as:

"human and social practice historically and culturally situated, creative and transformative of subjective and objective conditions, of an interdisciplinary and transdisciplinary nature. In addition, it is inserted in epistemic, ethical and political values, both local and international. The investigative practice is carried out in three main moments: 1) the activity of inquiry or search process (heuristics); 2) the process of organization and systematization of the data found (methodical), and 3) the process of theoretical construction and application of knowledge as a final product (episteme and pragmatics). These three moments are not necessarily chronological, but logical, epistemological and methodological, since each one requires special knowledge and practices for its development" (P 35).

Sustainability

The RAE defines sustainability as that "which can be sustained or defended with reasons". This concept was first introduced in the agricultural field towards the 70s, to seek solutions in pest control, to improve the nutritional problems of plants and include soil conservation techniques (Silva, Liliana and Ramírez, Omar, 2017; Vega, Jimena, 2021). Later the concept was taking a turn towards social and ecological aspects, in this regard, Gómez, Jenifer (2014) proposes sustainability as a strategy to find social well-being and ecological balance. Leff, Enrique (2004) proposes an ecological sustainability based on an environmental rationality that must be framed in a policy of diversity and difference that values nature from the different cultural and ecological codes, that separates it from the productivist conception and conceives it as an integrated and synergistic entity.

**Results bibliometric analysis**

In the development of the fieldwork from the qualitative paradigm and the bibliometric method, the approach of the categories allowed to identify the points of encounter and disagreement between educational research related to digital and environmental competences for sustainability in Latin America, as well as to identify the contributions, limitations and tensions that are evident in each of categories. namely:

Observation was made in the Colombian and Latin American context, based on the consideration of education, which contemplates it as "a

process of permanent, personal, cultural and social formation that is based on an integral conception of the human person, his dignity, his rights and his duties" (Law 115 of 1994.Art 1st).

For Ruíz, Guillermo et al (2020) education is a right and considers it as a social practice that has been present throughout the life of the human being, starting from the most primitive society to the most modern and technological. This author when convening the right to education recounts it since the nineteenth century and calls on educational institutions for the fulfillment of this right. Likewise, Gómez A. (2020), considers that it is necessary at the present time, to review the aspect of quality in education as a permanent challenge and challenge in the reconfiguration of the same for the present and future of the Latin American continent.

Now, when analyzing education mediated by digital environments, it is important to remember that data and the internet were one of the main legacies of the twentieth century and that they came to accompany all social processes worldwide, including education. In this dynamic, education mediated by digital scenarios or in virtual learning environments develops and requires skills in students, such as: autonomous and collaborative learning, critical and analytical thinking, better time management and autonomy, self-management and self-regulation of their educational process. The education of the XXI century advances towards the configuration of digital ecosystems that in the case of education have involved developments from EVA (virtual learning environments) isolated, then the implementation of the LMS (Learning Management Systems) that hosts the EVA with its subsequent advance in Virtual Campuses that are those that allow to concentrate in a digital architecture spaces for training with their respective interactions of management and educational administration. Digital educational ecosystems are conceived as integral environments for learning, as proposed by García-Holgado (2013). The educational digital ecosystem "goes further in that it privileges learning as a fundamental axis and allows from its internal dynamic operation the management and construction of collective knowledge of an organizational, technical and scientific type. An ecosystem in itself is transformed, adapts to change by self-management mechanisms and connects with other ecosystems forming a glocal network" (Acero, 2020, pg.98)

Likewise, Gómez Arévalo (2020), affirms that education mediated by the digital or developed in digital environments has been an important advance of distance education, and is considered worldwide as an opportunity due to the abundance of information it condenses, because it closes access gaps and allows greater inclusion and equality, protecting education as a right, this implies reviewing the curricula of higher education institutions in Latin America to transform them in an integral way.

Not only for Colombia but for Latin America, virtual education has become a challenge for teachers, who had to address the scenarios of education in times of pandemic without the necessary preparations, nor the required technological infrastructure. It is important to highlight in terms of García Aretio (2020) the so-called semantic forest given the divergence of denominations for the educational model: e-learning, b-learning, hydride, virtual, online, among others. This multiplicity of denominations is part of the complexity of the field of knowledge in which education mediated or accompanied by virtual learning environments is inserted and denotes its permanent change, the disruptions it faces and the dynamics of development in timeless and deterritorialized scenarios.

In the scenario of teacher training, many had to advance autonomously, without government support for online education and were singled out and disqualified by society and the union itself, since the quality of this educational model was questioned. In this regard, Jorge Balladares (2018) points out:

We must think and rethink the models of teacher training in ICT towards a continuous, synchronous and asynchronous, formal and non-formal, face-to-face and virtual, autonomous and collaborative digital training of teachers. (P.15) This digital training should seek the development of e-competences or digital competences for ICT practices of university teachers both inside and outside the classroom (Gregory and Salmon, 2013) cited by Jorge Ballares (2008.P.15).

As for hybrid education, which is a combination of face-to-face and virtual education, it emerges as a model that invites to modify the traditional way of imparting education and that today emerges as a necessity to address educational processes according to the new society mediated by data and the internet.

In this sense, education in hybrid models in Colombia is a challenge, since there are difficulties in the opportunity to access the necessary technological infrastructure and there is no economic capacity to access connectivity by users.

On the other hand, venturing into these new models of education in Colombia and in the Latin American region is complicated because there are gaps in the coverage of education, especially in the regions of the Orinoquía and the Colombian Amazon, which have not yet been resolved in the traditional model. In addition to the above, the disparity in the quality of education offered when comparing the results with international standards; thus, the score for Colombia of the PISA tests was (406), lower than the OECD average-488, and results of: Chile-438 and Mexico-416. Only Peru was surpassed with a score of 402. (Saint Mary Mauritius.2020)

The second category: ii. Research trends in digital and environmental skills. From the Horizon Reports, a permanent irruption of the digital in educational scenarios has been anticipated, which accelerates with COVID19. The 2019 Report outlined trends to accelerate technological inclusion, particularly in higher education. The 2020 Report, for its part, proposed an analysis of trends and challenges that was published before the start of the pandemic, so the scenario proposed in the first quarter of 2020 is now different, at least in the short term.

For research, digital educational scenarios are considered epistemological positions from technoscience, cyberculture, transdisciplinarity and strategic foresight. That is, a comprehensive understanding of digital environments from EVA to complex educational digital ecosystems-DTS.

All this is configured in an opportunity for the development and appropriation of environmental competencies which are key and must be in parallel to overcome the current environmental crisis, where critical thinking, collaborative, cooperative and networked learning would articulate and inform all actors and help to create the culture for sustainability.

The approach that underlies this research involves understanding the trajectory and complexity of digital and ecosystem environments, from their micro to macro levels, taking into account their natural development and formative intentions. This is how, from the EVA (Virtual Learning Environments) arise research related to the didactic, pedagogical, technological that contribute significantly to the understanding, redesign and usability. At this level, published research has made important advances with special emphasis on issues related to interactions, learning paths, autonomy developments, collaborative learning and the use of social networks as a learning mediation.

Regarding the development and use of LMS, research has placed emphasis on infrastructure and technological support; that is, essentially in their technological developments. At the level of virtual campus and digital educational ecosystems, research is incipient, which gives important perspectives to the advances that may occur now in times of acceleration of technology for training at a global level.

Understanding digital requires a transdisciplinary approach. The insertion of technology must be understood from educational innovation approaches that make it possible to capture and analyze QUAN + CUAL data and metadata in terms of strategic foresight. The permanent development of exponential technologies and NBIC permeates VPAs (virtual learning environments), virtual campuses (CV) and Digital Educational Ecosystems (DTS), this requires research beyond focused or situated projects. The challenge is related to ecologies for the environment, learning and research on cognitive transformation and

digital transformation, construction and prospective management of knowledge and modeling for problem solving in scenarios of uncertainty not only from technology, but social realities and the difficulties of the context especially in environmental matters, which have been the subject of this investigation.

Consequently, with the above, environmental competencies (AC) have been addressed from the need to document the phenomenon of the environmental crisis caused by climate change poses new challenges for education, in this sense, the commitment is for an education that promotes the development of knowledge, skills and competencies to manage the uncertainties and vulnerabilities generated by this phenomenon (Martín, González, Su Jung, 2022, p. 4). The above, by virtue of the fact that education has the potential to guide society in the transit towards sustainability, to the extent that it favors the acquisition of knowledge, competences, skills and values to mitigate the environmental crisis and develop adaptation and resilience processes.

The context of climate change has focused the focus of CA on the acquisition of skills for adaptation and mitigation (Núñez-Rodríguez, 2021); by virtue of the fact that this phenomenon alters the natural cycles of the planet and puts life at risk in all its manifestations; consequently, it is imperative that people prepare and acquire both the knowledge and skills to face environmental vulnerability, which from the perspective of Mora and Guerrero (2022, p. 308), implies having the ability to integrate individual resources (knowledge, procedures and attitudes) and the environment (information) to make decisions and act in unprecedented and changing contexts.

The approach of the CA represents a challenge for education, in the sense of putting the environmental problem as a curricular topic, which in turn represents teacher training processes for its implementation in the classroom.

The third category: iii. Contributions of environmental competencies versus sustainability to mitigate climate change. With the implementation of the 2030 Agenda, it is sought, through education, the acquisition of CA in terms of sustainability, in order to achieve the objectives set (SDGs), especially because the global goal is to keep global warming at 1.5 °C (IPCC, 2019) and to achieve this it is necessary to train citizens for environmental action and empowerment (Art. 6 UNFCCC, Paris Agreement, Art. 12).

In the Latin American context, the development of CA has been under the tutelage of EA, oriented more towards ecological literacy than to the development of environmental capacities (González-Gaudiano & Meira Cartea, 2020); In this sense, special emphasis has been placed on the acquisition of cognitive competences over action-oriented competences and the development of pro-environmental behaviours.

While ecological literacy is necessary in terms of acquiring reliable scientific knowledge, so is developing thinking skills to understand the complexity of the environmental crisis, mobilize knowledge to solve environmental problems, and make informed decisions about situations that may affect life; in this sense, the CA promote the development of critical thinking manifested in the deployment of responsible actions against the environment.

Although the international community recognizes the need to incorporate CA into curricula (UNESCO, 2021), in the Colombian context these have not been officially defined beyond the basic standards by competence (Mora, 2022), therefore, no route has been established for their incorporation; in this sense, Briceño (2022, p. 102) finds that the country has a debt in relation to the strengthening of the CA from educational policies articulated with the curricula.

In relation to the above, Wiek et al (2011), propose that, to meet the environmental challenges of the XXI century, education should tend to develop in key CA students, among which are:

1) Systems thinking: ability to collectively analyze complex systems in different domains. 2) Anticipatory: ability to collectively analyze, evaluate and create images of the future. 3) Normative: ability to map, specify, apply, reconstruct and collectively negotiate values, objectives and targets. 4) Strategic: Ability to design and implement governance interventions. 5) Interpersonal: ability to motivate enable and facilitate collaborative, participatory research and problem solving. As cited in Mora & Guerrero, 2022, p. 307.

However, the development of CA requires an epistemological framework that favors its development and facilitates the understanding of the environmental crisis as a multidimensional, inter and transdisciplinary problem (Facal, as cited in García-Vinuesa, et al 2022, p. 27), determined by political, economic, cultural, social and historical components that exacerbate it.

In this sense, the approaches for the development of the CA have been made from the perspective of an environmental education for change (González Gaudiano & Meira Cartea, 2020), understanding this as a change of attitudes and behaviors in relation to the care of the earth; however, despite advances in research on the development of CA, it has not been possible to consolidate an environmental culture for change.

Prosser-Bravo et al (2021), argue that the development of CA is associated with the development of participatory teaching practices that encourage the commitment and participation of students in solving environmental problems in their environments; this commitment focused on participatory, collaborative and project learning constitutes a thick line of research around CA.

Other developments seek to leverage digital technologies to advance CA acquisition. The use of digital technologies is increasingly common in learning environmental issues, to the extent that "they allow students to visualize and interact with objects or processes that would normally remain invisible to them due to their scale or the period of time in which they occur" Mahima Kala et al (2022). From this perspective, digital technologies have the potential to contribute to the understanding of environmental problems and the development of CA through virtual immersion processes.

On the other hand, sustainability implies the development of CA in which teaching and learning strategies must be included that allow a critical and deep reflection to transform the relationship between man and nature in a balanced and sustainable way (Gil, Daniel and Vilches, Amparo, 2006).

Sauvé, Lucie (2013) argues that it is necessary to develop critical, ethical and political skills, which integrate a series of knowledge of different types closely related to each other to achieve an ecosociety. Critical competence corresponds to a set of knowledge or knowledge that addresses the complexity of socio-ecological realities from the analysis, visions and possible arguments, Ethical competence is the ability to identify the values implicit in the discourses, the practices that allow classifying their own value system, compares, validates and reconstructs them. And political competition is associated with collective organization and power dynamics. These competences are integrated into "knowing", "know-how" and "knowing how to be". "Knowledge" is knowledge or knowledge related to the information and understanding of socio-ecological realities. "Know-how" is environmental strategic cognitive skills and "know-how" are attitudes and values that seek the common good.

These competencies point to environmental sustainability because they are theoretical-practical knowledge, skills, abilities complemented with socio-emotional skills, for the development of productive functions that contribute to good practices and improve methods in environmental management.

According to Leff, Enrique (2004) sustainability is related to the concept of environmental rationality and to achieve a sustainable future a dialogue of knowledge is proposed in the construction of sustainable societies, which problematize the concept of environmental knowledge and think about the construction between being and knowledge itself, as previously commented.

This environmental rationality must be the reason that guides sustainability and then the sustainable future is a social construction that emerges from the productive tension of the encounter of beings and the dialogue of knowledge. Gómez, Jenifer (2014) supports:

Ecological sustainability based on an environmental rationality that leads to rethinking production and generating "a reorganization of production based on the productive potential of nature, the power of modern science and technology, and the processes of meaning that define cultural identities and existential senses of peoples in diverse forms of relationship between human beings and nature" (P 133)

Leff, Enrique (2004) cited by Gómez, Jenifer (2014) refers to environmental sustainability as:

A sustainability based on cultural diversity and the potentials of nature defends cultural plurality, diversity of values in different ecological contexts and the preservation of the identity of different peoples, this because nature is conceived as an integrated and synergistic entity, instead of conceiving it as a capital stock (P133)

It is also important to recognize that sustainability, in addition to preserving the cultural and social identity of peoples, is fundamental in contributing to mitigating the effects of climate change. Zárate, Ángel and Miranda, Gloria. (2016) comment that one of the main responsible for climate change is the current productive system, which has an economic, globalizing and capitalist raison d'être, based on growth.

excessive industrial production, which uses the natural goods and services of the planet.

Therefore, it is essential to analyze the words of authors such as Leff, Enrique (2008) and De Sousa (2010) who propose to build sustainable societies that deconstruct that capitalist, extractivist rationality and tend towards a sustainable environmental rationality based on a philosophy that takes up the worldview of the ancestral, rural, common peoples and goes to the social struggles and the emancipation of the peoples from a decolonizing perspective.

**Methodological model**

Methodologically, the research was developed from the bibliographic qualitative paradigm, establishing dialogue with authors who have addressed the subject, in a window of observation of the last five years, mainly resorting to primary sources.

The results indicate that in Colombia there is a great tension between hybrid educational models, which should be reviewed to move from virtual campuses to digital educational ecosystems. There are regions with very low digital infrastructure, deficiencies in connectivity and little training of teachers and students in digital and environmental skills and competences.

Regarding research in and on digital environments, there are important advances: the tasks and challenges are to classify the information of

interest and to confront the validity of the source for research processes and frontier fields of knowledge.

On the other hand, there are advances in research for the development of CA in formal education: on the one hand, key competences have been identified to address environmental challenges, on the other hand, the need to address them from active pedagogies is recognized, finally, digital technologies are an opportunity for their development; However, the process of incorporating these into the curriculum has been slow, so it represents a challenge for public education policy and teacher training.

This highlights the tensions that exist between CA, curriculum and teaching competencies to develop them.

**Conclusions**

Thinking about developing mediated education in digital environments in Colombia and Latin America is complex from the social component and in educational and research capacities; Although progress has been made in coverage and access indicators, gaps persist that stem from traditional education models. It is highlighted that education in digital environments cannot be understood only from infrastructure and connectivity.

In Colombia and Latin America as a whole there are great difficulties, but the opportunities are greater overcoming the barriers of access, connectivity and availability of technological infrastructure for the development of secondary education or virtual education.

Teachers, with government support, must be trained in digital and environmental skills to address the hybrid education models that are required today by the new society that is based on knowledge networks and this commitment is a call worldwide.

There is still no significant progress in the development of digital educational ecosystems. Higher education institutions develop virtual campuses which align with university functions, while basic and secondary education institutions are fundamentally supported by digital repositories.

It must be understood that education in digital scenarios is different from the traditional face-to-face model. You cannot transfer one model to another: this implies designing learning routes and a different pedagogical proposal. Likewise, evaluation models should be reviewed, curricula that go beyond the disciplinary and research on the development and cognitive transformation of the subjects should be addressed.

In relation to CA, the trend in Latin America and Colombia is that these are approached from environmental education, with a focus on environmental literacy, although this knowledge is necessary, it loses relevance if it does not promote a multidimensional understanding of environmental problems.

The development of CAs in formal education constitutes an opportunity for the deployment of pro-environmental actions within the framework of environmental empowerment referred to in the Paris Agreement, which must be adopted and overlapped throughout Latin America, which is already marked by large gaps and in it the digital and the effects of climate change are accentuated, especially in the most vulnerable and excluded communities.

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