

# Digital competencies and challenges for today's teacher: A systematic review

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**Keywords:**

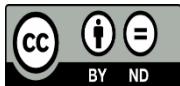
Digital competencies; teacher education; XXI century society; Colombia.

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**ABSTRACT**

The documentary review of articles on digital competence, at international and national level, evidences the interest and recognition of its importance in the teaching task taking into account the new social tasks in the framework of the tasks of the 4.0 revolution. The challenge for teachers today is to educate with strategies that articulate the inclusion of technological tools as a means to energize their practice and develop digital competencies taking into account the existing models. In this sense, this paper aims to contribute to the educational field, expanding the theoretical discussion of digital competencies in teachers.

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## 1. INTRODUCTION

Nowadays, talking about technology, communication and electronic media is fundamental because they are an inevitable part of everyday life. In fact, nowadays, a transformed society is evident, a society of information and knowledge mediated by Information and Communication Technologies (ICT), being education one of the areas where these contributions are most needed.

Raising the quality of education by making a reflexive use of ICT in favor of teaching and learning processes poses challenges and restructurings to education, due to the impact and demands that such transformations generate in the way society organizes. Hence the importance of the role of the teacher for the 21st century, where the use of ICT will depend on the level of appropriation of these tools to design and implement meaningful educational spaces [61].

The development of ICT has given rise to new ways of encoding information and structuring knowledge. Therefore, the success of incorporating ICT in learning spaces depends largely on the teacher's skills to organize the teaching and learning process optimally [6]. In this sense, [10], reiterate this approach in the framework of their research "*The virtual physics laboratory, a B-Learning environment for the development of competences in natural sciences*", where they point out that: The Implementation of the Virtual Physics

Laboratory Applying the Crocodile Software for the Development of Competencies in Natural Sciences, evidences a more effective learning to the extent that students are allowed to use this tool in an interactive way for the design and construction of their own electrical circuits, which were shared, discussed, valued and reinforced.

ICT should be understood as means that invite to teach and think about teaching, and their incorporation implies rethinking methodologies, which leads to the need to develop digital competencies in teachers, allowing them to be agents of change in the learning scenarios of the era of connectivity [55].

The integration of digital competencies in teachers contributes to the strengthening of the teaching-learning process, allowing students to have access to information and knowledge from different sources, turning the teacher into a “mentor” who guides the process.

This concern for the digital competence of teachers is not new, as it has been since the last decade and in particular since 2008 with the publication of the ICT Competency Standards for Teachers by UNESCO, which are intended to serve as a guide for teacher training institutions in the creation or revision of their training programs. Likewise, the International Society for Technology in Education (ISTE) also published the Spanish version of its standards in 2010, being the first exponents in the emergence of efforts on the appreciation of the digital competence of teachers.

In this scenario, this systematic review of digital competence is an attempt to contribute to the country's educational field, which shows opportunities for improvement in this regard; it is also a study that connects with the innovation agenda and its ways of carrying out the educational act, taking into account that the way of learning has changed, therefore, it requires a teacher with new skills, who is at the forefront of the advances and challenges that the knowledge society proposes.

## **2. 21st Century Society**

Digital technology is everywhere, so it is omnipresent. In the educational context, there is internet, computers, tablets, digital boards, among others. The big problem is how to train this new citizenship called digital citizenship. In different countries and through different organizations such as the OECD, UNESCO and the European Union have published various documents that say how to teach and work around digital technology, in particular the formative digital competence of future citizens. In the Spanish context, there is a document called the Common Framework of Digital Teaching Competence that is elaborated by [30], where a general framework is established so that teachers can design, develop and evaluate this competence.

Being a citizen of the XXI century implies, for [30], being in a time of change, so educators in a certain way have a leading role since they are responsible for training the citizens of this century. Among the characteristics present in the transition from the twentieth century to the twenty-first is that ICTs are omnipresent, since they are in all scenarios and spaces of personal, social, cultural, and economic life. The above has been the effect of being in a time where the planet functions as a global unit called Globalization since those borders that separate some people from others, a country with another, begin to blur; so there is a computer ecosystem that is necessary that the new society knows how to use them, has knowledge and competence to do so [17]. In addition, contact networks have been created as the so-called social networks and has given way to a knowledge economy, which every day becomes stronger. Therefore, whoever does not adapt to these times takes the risk of disappearing.

The pedagogy of transmitting was the one used in the education of the industrial society - 19th and 20th century [37], where learning was mechanical, that is to say, the competence at that time was to remember a lot of information and repeat it, to be competent in a solid, stable culture. However, the school of the 21st century [34] is educated for a liquid culture, metaphorically understood as adapting to knowledge that is constantly changing. For example, the Internet represents a universal library, but the Internet brings with it profound changes such as cultural forms of production and consumption of culture, obviously the forms adopted by these cultures are also different since there are new formats of representation of information (multimedia, audiovisual, hypertext, among others).

Another characteristic is that the individual homo digitalis [35] who has certain values and principles, knows how to interact through the network being part of the citizenship in the network; but the shadow that derives from this and human-machine interaction is increasingly necessary.

In view of the above, it is recognized that this is a historical moment when society is much more complex and requires having a positive attitude towards innovation, being able to use the knowledge they have to solve practical problems, knowing how to search for useful and relevant information, analyzing and having critical thinking, working collaboratively in teams and expressing themselves and communicating in different situations. In short, there must be subjects capable of adapting to change and building creative responses to the problems that arise [41].

Consequently, it is necessary talking about a pedagogy of learning in the education of the knowledge society [45], through active learning to make autonomous and innovative decisions in complex situations since the Knowledge Society demands changes in the way children learn, which represents a direct challenge to the way teachers must teach in the Digital Era where digital competencies have become a priority.

It should be noted that the pedagogical theory of learning is about 100 years old. It is not something new [14], [16], [40], [24], [62], [48], [25], these authors state that the school should train its students based on concepts such as that the student learns from his own experience, that he builds knowledge, that a personalized education is sought, that education should favor social learning and that a project-based method should be used, rather than learning mechanically.

### **3. Digital Competence in Education (DCE)**

The Spanish Royal Academy defines the term competence as “expertise, attitude, suitability to do something or to intervene in a given way”. For the [42], competence is the ability to respond to individual or social demands or to perform an activity or task. Each competency rests on a combination of interrelated practical and cognitive skills, knowledge (including tacit knowledge), motivation, values, attitudes, emotions and other social and behavioral elements that can be mobilized together to act effectively.

A Spanish educational body such as [1] states that a competency is a “set of knowledge, skills, attitudes that are acquired or developed through coordinated training experiences, which are intended to achieve functional knowledge that efficiently respond to a task or problem of daily and professional life that requires a teaching and learning process”.

Likewise, the Directorate General for Education and Culture of the [12] establishes that key competencies represent a multifunctional and transferable package of knowledge, skills and attitudes that all individuals need for their personal fulfillment and development, inclusion and employment. Summarized by [11] in his

study “*Competences in school education: more than a fad and much less than a remedy*” in which he refers that being competent in a field of activity or practice means being able to activate and use the relevant knowledge to face certain situations and problems related to this field.

Similarly, for the Colombian Ministry of National Education [38], competence is nothing more than a set of knowledge, skills, attitudes, understandings, and cognitive, socio-affective and psychomotor dispositions appropriately related to each other to facilitate the flexible, effective and meaningful performance of an activity in relatively new and challenging contexts. This idea is linked to what is stated by [10], where the contemporary context of Secondary Education in Colombia presents a panorama characterized by great challenges that are framed in the needs identified in the analysis of the closing of educational gaps at the national level, together with the comparative performance of the country in the development of competencies compared to international measurements.

Competences respond to the different knowledge (knowing how to be, knowing how to do, knowing how to know and knowing how to live together) of suitability [7] that contribute or redound to know how to be a person in this current and digitalized world, therefore, knowing how to be a person - or being digitally competent - leads to the ability to “deploy mental processes in a relevant way and in a functionally interdependent and intertwined way with the potential functions of technology” [3]. Therefore, it is assumed that digital competencies “play a strategic role in the formation of subjects, when technologies are made invisible, which are learned through practical experiences” [9].

However, in [28], digital competence is considered one of the 8 basic competencies in primary education in Spain and consists of having the skills to search, obtain, process and communicate information, and to transform it into knowledge, incorporating different skills, ranging from access to information to its transmission in different media once it has been processed, including the use of ICT as an essential element for information, learning and communication.

Thus, digital competence is associated with the search, selection, recording and processing or analysis of information, using different techniques and strategies to access it depending on the source and the medium used (oral, printed, audiovisual, digital or multimedia). It requires the mastery of basic specific languages (textual, numerical, iconic, visual, graphic and sound) and their decoding and transfer patterns, as well as applying in different situations and contexts the knowledge of the different types of information, its sources, possibilities and location, as well as the most frequent languages and supports in which it is usually expressed [45], [46].

For their part, [43] express that digital competencies not only encompass the acquisition of skills or abilities in the use of technologies; that is, it is not only enough to know how to use them, but rather, to know when, how and what to use them for. In short, the concept of digital competence goes beyond the use of software and hardware [17], so it has two perspectives: technical use of ICT and the use of knowledge or 21st century skills.

From the educational field, [15] state that these digital technologies such as the New ICT -NICT must be integrated into the educational process, thus representing a major challenge, mainly due to the characteristics of the agents involved. Part of the current teaching staff, in many cases born and trained in an analogical way, has to teach a student body that is entirely digital native. Indeed, digital natives are already in all stages of the education system, from primary education to university; therefore, it is necessary to develop digital competence in teachers.

Indeed, the ability to know-how with digital technologies will strengthen the student's skills and in turn deepen knowledge through information search, collaboration and communication [7].

However, teachers' beliefs and attitudes, their confidence and competence towards ICT, are fundamental in the pedagogical adoption of ICT, but the use that teachers make of ICT for teaching and learning depends on educational policies, their cultural coupling, the social and organizational contexts in which they live and work [49].

Under this perspective, an optimal digital teaching competence becomes an indispensable requirement to achieve excellence in the instructional exercise carried out by today's teachers.

It is not enough for students to acquire their own digital competence, as this does not guarantee that they will develop the necessary skills to design learning strategies and accompany students in their own process of competence acquisition [8]. In this sense, the paradigm shift that has taken place in recent decades regarding the role of the teacher [57], [27], [4], who is no longer limited to being a mere transmitter of information, but has become a guide or mentor, under the umbrella of the different socio-constructivist models of knowledge generation, has a lot to do with this.

Therefore, in the classroom, the figure of the teacher is still important, because what students do with technologies depends on the approaches and didactic learning that the teacher does, and that logically translates into the methodological teaching proposal, i.e., it is the types of activities that the teacher proposes with technologies that teaches, not the technology alone [50]. Digital competence is not "taught" or transmitted explanatorily, it is practiced and is integrated in all subjects.

However, it should be clarified that there are different approaches to teaching and learning: Learning by reception with ICT and learning by exploration and discovery on the Web [56], [53]. The first is that technology is used to teach in an expository way and the student learns what is transmitted with it (reception), for example, when a teacher uses the digital board to teach the class. The second is that it is the student who learns by exploring, researching, analyzing, discovering the knowledge and information that is on the Internet or Network and this means working with another methodology where the important thing is the use that students give to the resources they find in cyberspace and the teacher must pose problem situations for them to solve.

The proposals of this last form of learning are Personal Learning Environment (PLE); e-portfolio; Webquest; virtual reality; geolocation; project-based learning; Flipped Classroom; Ulearning; event-based learning; robotics; gamification, simulation and role-playing games. These basic projects revolve around the concept of e-activity [5], which refers to learning by doing, i.e., a teacher must plan activities based on a digital environment that vary in levels of complexity so that students acquire knowledge and develop competencies.

In this sense, some basic ideas of digital competence in teaching are summarized: less learning by reception and more learning by projects/problems; using digital objects in the classroom in various formats (texts, hypertexts, images, sounds, multimedia, video clips, maps, timeline, etc.); the student must create digital content; stimulating PLE and e-portfolios; generating communication environments (networks) and collective debates (synchronous and asynchronous), where the role of the teacher is important.

#### **4. Importance of Digital Teaching Competence**

Regarding the international context, in two studies done in Spain on teachers' digital competence, the first one in Castillay León by [47] and the second one in the Autonomous Community of Aragón by [22], both researches obtain as results that teachers have an average level of ICT performance for personal use such as information search, use of more common tools, etc., but they have a low level in didactic use, thus evidencing the need to strengthen the initial training of teachers and promote ongoing training programs for the development of this competence since teachers recognize the contribution that ICT can make to the teaching-learning process.

At the Latin American level, [60], in the case of Ecuador, also show the need for training to develop digital competence in teachers of General Basic Education in the canton of Loja, in order to enable the curricular integration of ICT in the classroom. In addition, they found that teachers have some mastery of technical aspects, but do not use technology for teaching practice because it requires higher level skills or abilities, which they do not possess.

[2], in his research on the development of teachers' digital competencies in basic education in Mexico, states that the Digital Skills for All (HDT) program created in 2007 by the Mexican government favors digital competencies in teachers, and this leads to the construction of a fair, democratic and plural society, where people have the ability to appropriate the knowledge available anywhere and use it to generate a benefit for all citizens; Thus, the national competitiveness index would be raised, which would bring with it a general welfare because ICTs are conceived as a fundamental element for the political, economic and social development of any country, especially Mexico.

## **5. Models of Digital Teaching Competence**

In the United States, one of the best known and most influential models is the National Educational Technology Standards for Teachers (NETS-T), proposed by the International Society for Technology in Education [31]. NETS-T includes five dimensions that it develops into a series of performance indicators. It also focuses on how teachers can facilitate their students' learning through ICT, addressing from the didactic part of the use of technology in the classroom (design and evaluation of materials and activities), to aspects of digital citizenship and teacher professional development. This model has been updated [33] and its development differs greatly from the previous proposal, now putting the focus on the importance of students thinking for themselves and driving their own learning. To this end, they establish a series of profiles and skills for the teacher to be trained and be the “catalyst” of that learning.

Another of the best-known models at the international level is the one proposed by [58], which proposes a general framework for establishing ICT competency standards for both in-service and pre-service teachers. This is a model with a purely organizational approach that, in addition to didactic aspects, addresses issues such as the integration of ICT in the curriculum, in organization and administration, or in the professional training of teachers.

[59] developed a reference framework for teacher professional development with ICT competency standards to help countries take a comprehensive approach to ICT in education so that teacher training responds to the country's vision. To achieve this articulation, it addresses ICT from six components (policy and vision, curriculum and assessment, pedagogy, ICT, organization, and teacher professional learning) and in three progressive stages (technological literacy, knowledge deepening and knowledge creation).

At the European level, the Joint Research Centre (JRC) of the European Commission [21] is the current European Framework for Teachers' Digital Competence (DigCompEdu). It is a model that includes aspects

related to the professional commitment of teachers and their professional environment, the use of ICT in the teaching-learning process or the empowerment of their students and the development of their own digital competence as citizens.

The European Commission's JRC Institute for Prospective Technological Studies in its vision of a European Knowledge Society in 2020 [51] predicts that personalization, collaboration and non-formal learning will play a central role in teaching and learning in the future. This implies that new competencies are needed to be successful in education, work and society, and new pedagogies for nascent ways of learning supported by technologies such as mobile devices, simulations, collaborative environments, multiplayer games and open online content.

Thus, personalization demands initiative, creativity, flexibility, responsibility and the inclination to take risks. Likewise, personalization brings with it ways to learn by oneself, reflect, and monitor one's own progress, as education is tailored to the learner who becomes the center of the learning process. Collaboration goes hand in hand with social competencies such as group work, networking, empathy, compassion and collective creation; for education this implies collaborations among peers and through networks and communities of practice. Finally, non-formal learning requires meta-cognitive, managerial and organizational competencies. It does not refer only to lifelong learning, but also of lifewide learning; this means taking advantage of the ubiquity of technologies to learn at any time and in any place by combining face-to-face and virtual spaces [51].

From the Spanish version, the Common Framework of Digital Teaching Competence of [29], takes as a basis the model of generic digital competence or citizen DigComp of the European Commission [20] and establishes that the five areas of CDD are: Information (searching for relevant and useful information on the network), Communication (communicating and interacting with other digital environments), Expression (creating content in multiple formats and disseminating it), Problem solving (using technology to solve problematic situations) and Safety (protecting oneself and developing safe behaviors on the Net).

In summary, the learning dimensions of teaching digital competence entails being digitally competent from an instrumental dimension, being able to use technology such as programs and software; cognitive-intellectual dimension, being able to transform information into knowledge; expressive-communicative dimension, knowing how to create content and communicate it on the Net; axiological dimension, acting with responsibility and democratic values; and emotional dimension such as building an emotionally balanced identity, i.e., not depending on it [30].

On the other hand, different countries have also developed their own frameworks and models. For example, the Chilean model proposed by [19] establishes five dimensions that correspond to key functions that a teacher develops in terms of technology integration, which are pedagogical dimension; technical dimension; management dimension; social, ethical and legal dimension; and professional development and responsibility dimension. In turn, and in a similar way, the British model known as DigiLit [23] identifies six key areas in teacher training including basic aspects of their work in the digital era: information search, communication, security, creation and evaluation of resources and activities, learning environments and professional development.

## **6. Digital Teaching Competence in Colombia**

Regarding competencies, the Colombian state, the Ministry of Education, uses the competency-based approach to parameterize or standardize the performance of teachers and students for the training processes

and evaluation system, as an alternative for the renewal of the educational system [7].

In Colombia, public policies related to ICT and education have been proposed since the 1980s [36]. These references include laws and decrees through which a national strategy for science, technology and innovation has been developed, as the country's economic and social policy. Among the documents that comprise this legal framework, the National Ten-Year Education and ICT Plans, the National Development Plans and Laws No. 1,341 and 1,286 stand out [39].

The development of human talent through the use of ICTs in education (Pequeños Científicos, Escuela Virtual, Transformar la Práctica Docente, and others); the qualification of education through educational innovation with ICT (Congenia, Red Virtual de Tutores, etc.); and the production and management of quality educational content in programs such as Eduteka, the Educational Innovation Centers and the National REDA Strategy [26].

[13] (Computers for Teaching) is a National Government program that seeks to generate equity through ICT, making ICT available to educational communities, especially in the country's public schools, by providing computer equipment and training teachers to make the best use of them. This program is one of the most far-reaching programs at the national level (with a coverage of 96.2% of the municipalities), in which the main goal is to reduce the digital divide by expanding access, use and exploitation of ICT in public educational spaces nationwide [44].

According to some studies [44], this program has had a positive and significant impact on academic dropout; on the results of the Saber 11 state test, it has contributed to increase the possibility of students to access higher education and has also increased access to and use of computers.

However, the scope of public policies and their results in Colombia have been affected mainly by two factors: the technological obsolescence of the equipment delivered and the lack of continuity in the development of the various initiatives over time, which may be due to changes in government and the lack of resources, which affects the hiring of teachers or those responsible for training and monitoring the digital literacy training processes [26]. These factors, added to the shortcomings in the management of technological infrastructure within some educational institutions, mean that the few initiatives that pursue purposes that go beyond the provision of technological infrastructure are only partially developed and are not sustainable in the different institutions where they are carried out.

In other words, despite having technological resources, teachers do not use them in their pedagogical work, because they do not have the necessary training in the use and management of digital competencies, so it is inferred that it is useless to provide institutions with electronic tablets, computers and others, if there is no investment in the ongoing training of teachers in the use and proper management of these resources and thus strengthen their digital competencies.

In the study made by [54], called "*The role of technological infrastructure in relation to the digital divide and digital literacy in 100 educational institutions in Colombia*", reaffirms the need to formulate and implement public policies that articulate actions for the provision, expansion and improvement of technological infrastructure, with strategies that ensure its appropriate use, differentiated and prone to the development of a digital literacy harmonized with the needs and contexts of teachers and students; without leaving aside, of course, the responsibility of educational agents in the construction of knowledge with the available technological resources. In this way, it will be possible to consider a true pedagogical integration



of ICT in the educational environment, which will have an impact on the social and academic environment.

Regarding the development models of Digital Competencies for Teachers in the Colombian context, since 2008 the MEN has been presenting to the educational community documents on ICT Appropriation, such as the “ICT Appropriation Route in Teacher Professional Development” to guide the training processes in the use of ICT by teachers in the country; after four years, they present a new version “ICT Competencies for Teacher Professional Development”, where one of its pillars is innovation [39].

ICT Competencies for the professional development of teachers, developed by the [39], is a proposal based on innovation and pedagogical use of ICT for the implementation of teacher and teacher management training routes. The MEN propose the Pentagon model of ICT Competencies with the purpose of strengthening *technological, communicative, pedagogical, managerial* and *investigative* competencies, with the effective and efficient use of ICT.

Competencies are developed and expressed in different levels of progress or degrees of complexity. The first level, or moment of *exploration*, is characterized by allowing the approach to a set of knowledge that constitutes the possibility of accessing states of greater conceptual elaboration. In the second level or moment of *integration*, the use of the already appropriate knowledge for the resolution of problems in diverse contexts is proposed. Finally, in the third level or moment of *innovation*, greater emphasis is given to creative exercises; which allows going beyond the knowledge learned and imagining new possibilities of action or explanation [39].

Another model developed in Colombia is the Spiral Model for the Development of Teaching Competencies TICTACTEP [55], which has as central referents the guidelines of the ICT Competencies Pentagon [39]; the contributions of [52] on the dimensions of Information and Communication Technologies (ICT), Technologies for Learning and Knowledge (TAC) and Technologies for Empowerment and Participation (TEP); the pedagogical guidelines of the Constructionist theory and the theory of complexity.

This model seeks to pose a new challenge that leads to professional qualification and a daily rethinking that allows teachers to advance in ascending octaves in the appropriation of ICTs in the ways of teaching. From the analysis of 10 models of use, integration and appropriation of digital technologies in education, the following foundations of the model were proposed: technological literacy, knowledge construction, development of digital competence and knowledge spirals [55].

It should be noted that the Technological, Pedagogical, Communicative, Management and Research competencies proposed by the ICT Competencies Pentagon [39] remain in the model, but a differentiation is made in the spiral progress of each competency, for which the ICT TAC and TEP levels are proposed, which in turn are divided into 4 sub-levels of development (Initiation, Exploration, Appropriation, and Innovation).

According to [52], ICT are the starting point in the development of digital competencies as they are facilitators of professional teaching performance. But the TAC are the product of genuine and meaningful uses of ICT, with the purpose of learning in a better way, establishing dynamics and training practices that involve exploration of the various didactic uses of digital technology. And PETs are the dynamics that occur when there is effective appropriation of ICTs and social networks in scenarios of permanent opinion of people, which through collaboration and participation generate social movements.

## 7. Conclusions

The advances and new challenges demanded by the knowledge society motivate the system to evolve every day. Currently, the digital era is facilitating the daily life. Therefore, an optimal teaching digital competence becomes an indispensable requirement to achieve excellence in the instructional exercise carried out by today's teachers.

The review of literature on digital competencies in the teaching profession, independent of the level of education, reaffirms the idea that it is important for teachers or future undergraduate professionals to acquire these competencies for practical classroom practice. In addition, it should be clear that digital competence is not taught or transmitted explanatorily, but is practiced and is integrated in all subjects.

On the other hand, this documentary review, which was oriented by a search in the international and national order, evidences the gap that exists in the literature comparing Europe with Latin America, especially Spain vs. Colombia. Most of the literature was referenced from Spain, taking into account that they are listed by their National Institute of Educational Technologies and Teacher Training -INTEF and its Common Framework for Digital Competence in Teaching, which in the light of this research is interesting to study and to take into account at the country level.

In that order of ideas, there are many models for the development of the CDD (UNESCO, ISTE, European Commission, among others) but each study chooses in practice the one that goes according to its purpose. For the present one, the Spiral Model of Development of Teaching Competences TICTACTEP of [55] calls the attention for its central references and for the analysis of 10 models of use, integration and appropriation of digital technologies in education; although there is no evidence of its implementation in a specific case study it is recommended as a central part.

In short, it is proposed that there is a need to change the learning of technology for learning with technology, and it is there where the term digital competence is focused, which not only covers the acquisition of skills or abilities in the use of technologies; that is, it is not only enough to know how to use them, but rather, to know when, how and what to use them for [43].

From all the above, it is concluded that it is relevant to continue along this path of research and persist in the development of digital competencies in the educational field, after having a more complete view of the whole problem and then help to improve the teaching-learning process.

Up to this point. There is a perspective of this whole subject with different conceptions of competence; although it is necessary to recognize its own dynamics and its particular characteristics, it is also essential to generate a conceptual consideration that leads to propose solutions that are much more applicable to different educational contexts.

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