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Integration of technological tools in the teaching-learning process: an analysis of their impact and effectiveness

Grisel de la Concepción Soto Grau*

Abstract

The article addresses the impact of technological tools on the teaching-learning process, based on a survey of teachers and an exhaustive bibliographic review. The results reveal that, although educators are incorporating technologies into their pedagogical practices, a significant digital divide persists that limits their effectiveness. Many students lack the preparation and training necessary to use these tools optimally, which can affect educational quality. The research highlights the importance of implementing continuing education programs that equip teachers with the skills required to effectively integrate technology into the classroom. Likewise, the need to close the digital divide is emphasized, guaranteeing adequate access and resources for all educators and students. In conclusion, although technological tools offer great opportunities to improve learning, their potential is not being fully realized due to lack of preparation and inequalities in access.

Keywords: Teaching-learning process, digital tools, education, digital divide, training

* Licenciada ISTUCED gsoto@deming.edu.ec
https://orcid.org/0009-0001-4000-2989

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Integración de herramientas tecnológicas en el proceso de enseñanza aprendizaje: un análisis de su impacto y efectividad

Resumen

El artículo aborda el impacto de las herramientas tecnológicas en el proceso de enseñanza-aprendizaje, basado en encuestas a docentes y una revisión bibliográfica exhaustiva. Los resultados revelan que, aunque los educadores están incorporando tecnologías en sus prácticas pedagógicas, persiste una brecha digital significativa que limita su efectividad. Muchos estudiantes carecen de la preparación y capacitación necesarias para utilizar estas herramientas de manera óptima, lo que afecta la calidad educativa. La investigación destaca la importancia de implementar programas de formación continua que equipen a los docentes con las competencias requeridas para integrar la tecnología en el aula de manera efectiva. Asimismo, se enfatiza la necesidad de cerrar la brecha digital, garantizando acceso y recursos adecuados para todos los educadores y estudiantes. En conclusión, aunque las herramientas tecnológicas ofrecen grandes oportunidades para mejorar el aprendizaje, su potencial no se está aprovechando completamente debido a la falta de preparación y desigualdades en el acceso.

Palabras clave. Proceso de enseñanza aprendizaje, herramientas digitales, educación, brecha digital, capacitación.

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INTRODUCTION

The teaching-learning process is a complex educational phenomenon that involves the interaction between the teacher, the student and the content to be taught. It not only refers to the transmission of information, but also involves the active construction of knowledge by the student.

In this process we find key elements, in the first instance we must analyze the teacher, in its crucial role, not only acts as a transmitter of knowledge but also as a guide, facilitator and motivator, creating an environment conducive to learning. He/she must have a broad knowledge of the subject he/she teaches and of the characteristics and needs of his/her students.

For his part, the student is the protagonist of his own learning; each student has a unique way of learning and experiences that influence the way he processes the information received. Other important components of this process are the content, the context, the methodology used and the evaluation. We can define teaching-learning as a dynamic cycle in which various factors and actors are combined, where knowledge is constructed from an active and contextualized interaction.

According to (Abreu Alvarado et al., 2018), teaching and learning processes are integrated to represent a unit, focused on contributing to the integral formation of the student's personality and favoring the acquisition of different knowledge: knowledge, skills, abilities, competencies, skills and values.

Throughout history this process has not remained unchanged, on the contrary, in his article Soft skills in education: an approach for holistic and meaningful learning, referring to education, (Soto, 2024) states "Throughout its evolution, this process has undergone major changes, from an elitist and religious education through an

education focused on the imposition and memorization of dictated content to the current education oriented to the construction of knowledge by the student".

In the past, teaching was mostly theoretical and based on memorizing information. Students listened to long lectures from their professors, who relied mainly on textbooks and other printed materials to transmit knowledge. Practical activities were infrequent and, when they did occur, they were generally only demonstrations in class, with no real link to the application of that knowledge in everyday life. This form of teaching did not stimulate students' innate curiosity or encourage active exploration, as it focused more on repeating data and concepts than on a deep and critical understanding of scientific phenomena. The purpose of this article is to analyze the impact and effectiveness of the application of technological tools in theteaching-learning process.

What is the current context in which the teaching-learning process takes place?

According to Puiggrós, in his article Historia de la Educación: At present, globalization and digitalization of communications burst in, disarticulating educational relations in all social spaces. Inside and outside educational institutions, television and the Internet connected students and teachers with the world. The boundaries between education and communication became more difficult to define. The voices transmitting information and knowledge multiplied, taking weight away from school discourse. The new generations began to form themselves as self-taught, inverting the order of transmission of culture that existed since the origins of humanity. (Puiggrós, 2016)

The current context of education and the way of imparting knowledge is characterized by several key elements that have transformed both teaching methods and the role of the student and

the teacher. Among these elements is the integration of digital tools in learning, which have come to revolutionize the educational paradigm. Online education, learning management platforms (LMS), multimedia resources and educational applications facilitate access to content and promote an interactive learning experience. In addition to this, teaching today is flexible and personalized, because it seeks to adapt the content and pace of learning to the specific needs of each student, which favors effectiveness and inclusion. Finally, there are innovative methods such as project-based learning, cooperative learning and flipped learning, which encourage the active participation of students and the development of critical and creative skills.

In addition to academic knowledge, increasing importance is being given to the development of social-emotional skills, such as empathy, collaboration and resilience, which are essential for success in an increasingly complex and changing world. We are not content to train students who know the content, but rather, citizens of the world capable of transforming it.

Education today faces an interconnected world, making it necessary to incorporate global and multicultural perspectives into the curriculum, fostering understanding and respect for diversity. In turn, assessment methods are increasingly inclusive and formative; they seek not only to grade, but also to provide feedback on the learning process and help students identify their strengths and areas for improvement.

In response to the difficult environmental, economic and social situation the planet is going through, it is essential to include environmental, financial and peace-promoting topics in the curricula. Today's education seeks to adapt to the needs of the 21st century, promoting meaningful and relevant learning in an ever-changing world. Educational institutions must assume these

changes and adapt to form informed students committed to the challenges of contemporary reality.

Faced with generations of digital natives, the use of technological tools is essential to ensure the quality of learning, some of them and their benefits will be analyzed below.

Technological tools: In what sense do they favor the development of the teaching-learning process?

In this section we will review some of the most used technological tools in the teaching-learning process to analyze the impact they generate.

Among the digital tools that can be used for this purpose are simulations such as Labster or PhET. With this type of tools, the teacher maximizes learning opportunities, in addition to offering practical and effective ways to explore scientific concepts. By integrating these tools into the classroom, educators can improve conceptual understanding, foster practical skills, and promote an active and motivating learning environment.

The benefits of these tools are innumerable, including interactivity, as they allow students to experiment with scientific procedures that, in reality, would probably be costly, dangerous or difficult to develop; coupled with this, students advance at their own pace, promoting autonomy in learning. Many of these simulations include game elements that encourage motivation because learning is more fun and attractive, as well as facilitating the acquisition of knowledge because they allow the visualization of complex concepts that are difficult to understand only through texts or lectures. They encourage an inquiry approach, where students can formulate hypotheses, perform experiments and observe results in a controlled environment. In the case of PhET, access to its simulations is provided free of charge, making them accessible to a

large number of students and educators, regardless of their financial situation. On many occasions, it is difficult for teachers to explain processes such as photosynthesis, cellular respiration, free fall, excess reactant or natural selection; however, using these tools, it is possible to teach in a didactic and animated way.

Other applications that facilitate the teaching-learning process are mobile applications such as PlantSnap, which allows us to recognize trees, plants and flowers just by taking a picture; this not only has a positive effect on self-directed learning and students' interest in Biology, but also promotes environmental care, since PlantSnap plants a tree for each person who downloads the application. According to (Espeso, n.d.), PlantSnap has the ability to improve recognition over time thanks to artificial intelligence. In other areas of knowledge we also find these applications, an example of this is Duolingo which is the app for language learning, par excellence; Google Earth, which is the Google tool that allows you to travel around the Earth and closely observe geographical features, buildings, natural wonders, historical monuments in 3D or high resolution images of the seabed, or GeaCron, an interactive and flexible historical atlas that allows you to check the geopolitical changes in the world throughout the different periods of history.

Tools such as Merge Cube, GeoGebra or Google Expeditions are examples of the application of 3D models and augmented reality. With them, students can visualize cellular structures and biological systems, or observe a body in motion, which generates great benefits to immersive teaching in the understanding of natural sciences.

The area of academic assessment is not exempt from these benefits, since, with the use of tools such as Kahoot, Quizizz, Mobbyt or Cerebriti, this vital part of the teaching and learning process becomes more dynamic and participatory. With these

technological tools for formative and summative assessment in the classroom, students can answer questions in a playful environment, which reduces the anxiety associated with traditional assessments; in addition, students receive instant feedback on their performance, allowing them to quickly identify areas for improvement and celebrate their successes. Many of these applications encourage teamwork and collaboration, which helps students socialize and learn from their peers.

In addition to these considerations, we can add other social considerations. These technologies can bring educational content to areas that are difficult to access or in emergency situations, through low-tech strategies such as radio communication. We should also highlight how technology favors the accessibility and personalization of content for students with disabilities, in addition to its potential to facilitate the creation and adaptation of educational resources, through open-access tools, as well as the diversification of learning strategies.

The GEM Report (Global Entrepreneurship Monitor) on technology and education usually addresses the relationship between entrepreneurship, innovation and education in different contexts. In the 2023 report, the focus was on the role of technology in education. It examined the technological tools used in educational environments and how they can enhance learning and facilitate access to quality education.

In order to reinforce the above, the criteria of teachers from the Instituto Superior Tecnológico Universitario Corporativo Edwards Deming (ISTUCED) and the Colegio Particular Misión Geodésica, both located in the city of Quito, Ecuador, were taken into account.

MATERIALS AND METHODS

An exhaustive search of academic literature related to the impact of digital technologies in education was conducted. Articles were selected that address both theoretical aspects and case studies showing practical applications and results.

A critical analysis of the information collected was conducted, identifying patterns, trends and gaps in the existing literature. Data Analysi

The data obtained from the surveys were analyzed using descriptive statistical methods. The Excel tool was used to perform frequency analysis, tables and graphs to allow a clear visualization of the results.

Open-ended responses were categorized and analyzed qualitatively to identify recurring themes and participant perceptions.

A selection of academic articles with relevant studies on the use of digital technologies in education, obtained from reliable databases, was compiled.

Fundamental texts in the field of education and technology, which provide a solid theoretical framework, were reviewed.

The analysis of reports published by international organizations on trends and statistics on the use of digital technologies in education was carried out

Data collection instruments

Data collection instrument According to (Arias-Odón, 2012), a data collection instrument is any resource, device or format (paper or digital), which is used to obtain, record or store information.

During this research, structured surveys were used which, as mentioned above, were applied to teachers from both institutions. These included closed and open questions on the use of digital technologies, their effectiveness, preferences and perceptions.

The Google Form platform was used to facilitate the distribution and collection of the surveys in an efficient and anonymous manner.

According to (Arias-Odón, 2012) a survey is defined as a technique that aims to obtain information provided by a group or sample of subjects about themselves, or in relation to a particular topic.

The surveys were written considering the educational context and the research objectives. The questions were formulated to obtain specific information on the use and perception of digital technologies, as well as their impact on the teaching-learning process.

The survey included questions on the type of digital tools used by teachers, their frequency of use, perceptions of effectiveness and challenges faced.

The selection was made through random or purposive sampling, ensuring diversity in terms of experience, disciplines and educational contexts. To determine the size of the sample, a formula was used to calculate the size, which showed that, for the total number of teachers between the two institutions, which amounts to 105, 15 from the Mission Geodesic School and 90 from ISTUCED, a sample of 30 surveys was necessary. For the analysis of results, 33 responses on the proposed topic will be used.

The confidentiality and anonymity of the participants was guaranteed, and informed consents were obtained before the

application of the surveys. The purpose of the research and the use to be made of the data collected were explained.

These materials and methods allowed us to obtain a clearer picture of how digital technologies are influencing the teaching-learning process, providing valuable data that could contribute to future research and to the improvement of educational practices in digital contexts.

RESULTS

This analysis is based on data collected from a survey related to the use of technology in education. The following is a breakdown of the results of each question and their implications:

Question 1 of the survey inquired about the level that the teacher teaches, thus showing that 81.8% provide their knowledge at the Higher level, which is logical given the proportion of teachers in the selected institutions. The 12.1% are dedicated to teaching secondary education and 6.1% work at other educational levels.

In question 2, related to the subject taught, the highest percentage, 9.1% teach Marketing, the rest of the subjects are classified as "miscellaneous".
This may indicate that the survey includes a wide variety of disciplines, in addition, it may be relevant for further analysis of how technological tools are perceived and applied in different areas of knowledge.

In question 3, on the use of technological tools, it was found that 100% of the respondents use them in their classes. This finding is significant, since it indicates a widespread adoption of technology in teaching, which highlights the need for continuous training and

the availability of technological resources in the educational environment.

Question 4, related to the technological tools most used by teachers, yields the following data: 90.9% multimedia resources, 66.7% videoconferencing, 33.3% educational management platforms and 15.2% augmented reality.

The high use of multimedia resources and videoconferencing suggests that teachers prioritize forms of visual content and real-time interactions. However, the low use of augmented reality may point to an opportunity for its promotion and training, as it could enrich the learning experience.

In question 5, on the impact of technology on students, almost 97% of teachers report a positive impact, which supports the notion that technology integration benefits the educational process. This result can be a strong argument for investment in educational technology and teacher training.

In question 6, an analysis is made on the benefits that technology represents for students, from which it was obtained that: 69.7% underline the importance of technology in the formation of key skills for students in the digital era; while 66.7% expose the importance of these technologies in the participation and motivation of students.

Despite all the benefits that this type of technology brings to the teaching-learning process, we find a large digital divide in some sectors of the population, hence the result of question 7, which inquires about the difficulties of students in the use of digital tools,

shows that 51.5% of teachers say that their students do not master them, while 48.5% respond that they do handle technology in the classroom.

This finding suggests that more than half of the students, according to the respondents, face obstacles in the integration of technologies, which could negatively affect the quality of teaching and learning. This data is crucial to identify areas where additional intervention and support is required. It is possible to think that this result responds to the type of student population representative of the selected institute, since most of them are adults residing in areas with difficult access to connectivity, which poses additional challenges for their training and access to educational resources. As causes of this problem, the teachers corroborate our conclusions when they state: They do not have access to the Internet due to geographical location; depending on the age of the students, some do not handle technological tools very well; students from the provinces have serious difficulties with the use of basic technologies, some do not have the conditions or knowledge, they do not even know how to use Word, among other considerations that represent a great contribution to this research.

Regarding question 8, the training received by teachers in the use of technological tools has a positive influence on the development of the teaching-learning process, 69.7% of the teachers affirm having had this type of preparation while 30.3% have not received this benefit.

The fact that most teachers have received training in the use of technological tools suggests an effort on the part of educational institutions to train their teachers. However, 30.3% still have no training, which may severely limit their ability to teach in an

increasingly digital environment. This situation should be analyzed by the educational institutions involved and strategies developed to enable teacher training in these areas.

According to the type of training that most contributed to the knowledge of teachers, in the use of these tools, addressed in question 9, it is observed that 62.5% consider that it was the online courses, while 16.7% mention seminars, 12.5% face-to-face workshops and only 8.3% state that it was other types of training that had an impact in this regard. This highlights the effectiveness and convenience offered by online learning formats. On the other hand, face-to-face seminars and workshops have a lower contribution to training, according to teachers.

Question 10, on the support teachers need to improve their use of digital tools, indicates that 63.6% of the respondents express the need for additional training to improve their use of digital tools, emphasizing that continuous learning is fundamental for their professional development. In contrast, the need for technical resources and time for planning, although significant, receives equal attention (15% and 15.2%, respectively). This suggests that, while training is crucial, an environment that facilitates the implementation and effective use of technologies is also required.

In addition to being interested in the teachers' experiences with the use of technological tools and their impact on the teaching-learning process, emphasis was placed on their criteria on the improvement process; thus, in the last question (11), emphasis is placed on the changes they suggest implementing in their institutions to encourage better use of technological tools in the classroom. One of the most recurrent recommendations in the responses was the need to implement training programs for teachers. Responses such

as "Specialized training", "Practical workshops within the institution" and "Provide training to teachers for the correct use of technological tools" highlight the importance of having trained personnel to take proper advantage of the technological tools available. This trend suggests a general recognition that teaching skills are fundamental for the effective incorporation of technology in the teaching-learning processes.

Another critical factor identified is internet connectivity and technological infrastructure, mentioned in several responses as "better internet service" and "better internet signal in classrooms". The availability and quality of connectivity is perceived as a significant obstacle to the use of online tools. The need to guarantee access to platforms and the existence of basic equipment, such as projectors and computers in classrooms, was highlighted in the suggestions: "Guarantee the existence of projectors and PCs in each classroom" and "the main problem in the implementation of technological tools is internet connectivity".

The demand for greater access to educational platforms and the acquisition of advanced tools such as simulators and augmented reality software were also expressed in multiple responses. For example, it was proposed not only the purchase of licenses, but also the implementation of refresher courses and E-learning videos, as ways to enrich learning. These suggestions show an interest in diversifying the technological tools used in the classroom and in providing resources to facilitate teaching.

The responses also suggest the application of innovative modalities in teaching, such as the proposal to conduct webinars and the use of podcasts. These initiatives can not only promote training, but also create a more dynamic and accessible learning environment. Respondents highlight the importance of updating and planning

ongoing training to ensure that teaching staff remain up to date with technological tools.

It is relevant to mention that some responses, although to a lesser extent, leaned towards the idea of not requiring changes ("None"), which could indicate a satisfaction with the current state or a resistance to change. However, one challenge stands out in multiple responses: students' detachment from institutional policies and the need to reinforce compliance with educational norms and schedules.

Analysis of the responses suggests that institutions need to take a multifaceted approach to encourage the use of technology tools. This includes teacher training, improvement of technological infrastructure, access to diversified educational resources, and implementation of innovative teaching modalities. Addressing these aspects could generate an enabling environment for the effective integration of technology in education, aligning with the needs and expectations of respondents.

The present research highlights the predominance of the use of technological tools in teaching, especially at the higher level. Although perceptions of the impact of technology are predominantly positive, there are areas, such as augmented reality, that could be further explored. In addition, the development of digital skills and access to information are key benefits that should be prioritized in education. Future studies could focus on the effectiveness of various technological tools and how they can be optimized to support learning at different educational levels.

The data analyzed indicate that, despite having a higher proportion of teachers who consider that their students have training in digital tools, there is still a significant perception of difficulties in their use. The preference for online courses as the most effective form of

training and the demand for additional training indicate that continuing education is essential to empower teachers in an evolving digital environment.

These findings suggest the need to implement more adaptive and accessible training programs, as well as the creation of an enabling environment that includes technical support and time for planning. Collaboration among teachers can also be an effective strategy for sharing best practices and resources.

CONCLUSIOS

The results of the survey conducted allow us to obtain valuable information on the use of technologies in education and the dynamics surrounding it in the current context. The predominance of teachers who teach at the higher level (81.8%) suggests that technology integration at this level is more advanced compared to secondary education. This highlights the need to encourage a more robust use of technology at lower educational levels because of its importance in building the knowledge base of students.

All teachers surveyed use technological tools in their classes, indicating a clear adoption of educational technology; however, the predominance of multimedia resources and videoconferencing reveals a preference for visual and interactive methods, leaving a significant opportunity to explore the use of emerging technologies such as augmented reality, which still has a low level of adoption (15.2%).

The positive impact reported by almost 97% of teachers, in relation to the technification of learning, underlines the effectiveness of technological integration, which justifies investment in technological resources and teacher training. However, the

identification of a significant digital divide, affecting 51.5% of students, who do not master the tools, poses a challenge that educational institutions must address. The lack of digital skills, especially in less connected areas, demands emphatic and personalized interventions to overcome these limitations.

In relation to teacher training, it is concluded that, the fact that 69.7% have received training in technological tools, is encouraging, although the 30.3% who have not had such training, represents a risk to their performance in an evolving educational environment. The fact that online courses rank second as the most effective training sessions (62.5%) suggests that institutions should prioritize these modalities as part of their educational offerings.

On the other hand, the need for additional support and resources (63.6% of teachers indicate this) to improve the use of digital tools, highlights the importance of creating an enabling environment for teaching. Suggestions to implement stronger training programs, improve technological infrastructure and ensure connectivity are critical steps that institutions should consider to increase the effectiveness of their educational practices.

Finally, the recognition of the importance of adopting innovative teaching modalities and providing teachers with accessible resources stands as a central pillar in the educational modernization strategy. The emerging recommendations around ongoing training and access to technological resources reflect the desire to create a more inclusive and adaptive classroom. In light of these findings, it is crucial that educational institutions develop a comprehensive action plan to address the various barriers that teachers and students face in the effective use of technology in education.

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