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Using ICT in a Hybrid Environment for Science Education: A Postpandemic Learning Experience

Raúl Prada Núñez[1], Cesar Augusto Hernández Suarez[2], Audin Aloiso Gamboa Suárez[3]

[1] Master in Mathematics Education. Research professor at Universidad Francisco de Paula Santander. E-mail: raulprada@ufps.edu.co. Orcid: https://orcid.org/0000-0001-6145-1786

[2] Master in Mathematics Education. Research professor at Universidad Francisco de Paula Santander. E-mail: cesaraugusto@ufps.edu.co. Orcid: https://orcid.org/0000-0002-7974-5560

[3] Doctor in Educational Sciences. Research professor at the Universidad Francisco de Paula Santander. E-mail: audingamboa@ufps.edu.co. Orcid: https://orcid.org/0000-0001-9755-6408

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ABSTRACT

Combining the face-to-face and virtual modality in a hybrid environment is a didactic strategy that currently provides the development of knowledge and skills in educational institutions at all levels, allowing the creation of educational environments without space and time restrictions. The objective was to describe the use by teachers in the implementation of a virtual platform and ICT tools under a hybrid environment in the process of teaching and learning science in secondary education after the return to school due to the pandemic. It was developed under a quantitative, descriptive and field design approach. The sample consisted of 32 teachers who teach science in middle school, using a semi-structured questionnaire as a data collection technique. It was verified that after the pandemic, some teachers returned to their traditional practices and did not continue with the use of ICT devices, such as the virtual platform to support the teaching and learning processes of students in natural sciences, which does not favor the construction of hybrid learning environments, so it is necessary to work on a digital culture aimed mainly at teachers, since the use of ICT alone does not make a difference, but needs the teacher in terms of curricular organization and its mediation to promote science learning.

Keywords: Technological teaching, education; hybrid education.

INTRODUCTION

The scientific and technological revolution is present in all areas of human performance; there are transformations in the paradigms and production systems of science and technology; above all, its influence is evident in the changes that must be generated in the teaching-learning processes at different educational levels (Ramírez, 2020).

Education has a strategic character for the development of the country. Hence the challenge of the educational system is to train people where their autonomy is favored, which adapts to their needs and demands (Gómez, 2020a, 2020b; Cabero, 2014) through learning experiences that allow their development not only at the academic, social, family, cultural but also scientific level. To achieve this, the teacher stimulates students through innovation in strategies for a meaningful construction that can serve in the resolution of activities (Gómez-Valderrama & Ramírez-Sánchez, 2017) and, be incorporated into their experiential field so that, in the case of science subjects, such as physics, chemistry and biology, are part of their knowledge, thus facilitating learning.

Acosta & García (2012) argue that teaching strategies consist of providing support to the constructive activity of students, working together to impart the necessary knowledge for their personal, educational and professional development by giving them study tools that guide and help them throughout life. Teaching is becoming increasingly innovative, emphasizing the transformation of teachers' digital competencies to provide students with procedures or resources to elicit learning (Solis & Jara, 2019) and content through various means to achieve understanding within a context.

At this point, the student tries to grasp and retain all the knowledge imparted by the teacher through the means and strategies used. In the case of science, many times, studies have been oriented to the motivations of high school students of biology, physics and chemistry and the influence of teaching methodologies on their interests (Méndez, 2015). As well as, the evaluation of educational software used in teaching as in physics (Navarro et al., 2012), there is a criterion for selecting technology and didactic strategies (Rivero et al., 2013). However, other studies have focused on using interactive technological tools (Arias et al., 2012).

Virtual education can be present at all educational levels. However, it is more common in higher education, where it considers the student as an autonomous subject, committed to his learning, who uses technology, studies from home or with flexible schedules, where he organizes his time by himself with the help of multimedia materials and the guidance of the tutor (Díaz et al., 2021). Likewise, hybrid learning (b-Learning) is another training modality that combines virtual and face-to-face education. Both e-Learning and b-Learning seek to strengthen the educational process and break space-time barriers (Salinas et al., 2018).

However, in Colombia, virtual education has been a modality little used in educational institutions in basic and secondary education since they prefer to continue with traditional models of face-to-face education for the development of teaching and learning processes, but the pandemic associated with covid-19 contributed to accelerating the processes associated with digital transformation (Hernández et al., 2021; Rincón Leal et al., 2021; Prada et al., 2022). Likewise, the state of Colombia, through the National Ten-Year Education Plan 2016-2026 (Ministry of National Education [Mineducación], 2017), promotes the relevant, pedagogical and widespread use of new and diverse technologies to support teaching, knowledge construction, learning, research and innovation, in order to strengthen development for life (Mineducación, 2022). In addition, Mineducación defined concrete projects for the design and updating of policy tools through curricular guidelines and orientations aimed at the development of skills necessary for the fourth industrial revolution, and one of the topics is related to the guidelines for basic and secondary virtual education (Departamento Nacional de Planeación [DNP], 2019).

In this sense, elementary and middle school educational institutions approached the virtual modality, although not in a systematized way by teachers. Thus, the lack of implementation of these platforms and the hybrid modality in educational institutions is evident. As a consequence, both teachers and students do not have useful digital competencies to approach this modality because they continue, in most cases, to work with traditional resources. In addition, the change in the modality in which these teachers teach face-to-face classes to virtual classes can generate distrust or fear as it is an unknown terrain because its implementation becomes a complex path.

On the other hand, the proposed research aims to reinforce the knowledge about science teaching-learning using a hybrid modality environment in secondary education institutions. For this purpose, it requires a teacher who assumes the teaching-learning process by incorporating technology into his pedagogical practice. Therefore, this article proposes an advance regarding the use of technological tools in terms of the hybrid modality in secondary education. Therefore, teachers at the secondary education level have the opportunity to appropriate the teaching-learning process in a hybrid environment with the use of ICT and add a differential, which establishes the use of technological tools that constitute a learning space through the encounter and interaction in which, and through which, the subjects co-organized in the social web support each other (Gómez-Valderrama et al., 2020; Hernández-Suárez et al., 2021).

In practice, examining teachers using technological tools in a hybrid environment means articulations to the existing needs of the environment and conducive to teaching with ICT, and provokes ideas in education with technology. Thus, the objective was to describe the use by teachers in the implementation of a virtual platform as a didactic tool under a hybrid environment in the process of teaching and learning science in secondary education.

Technology platforms and ICT in a hybrid environment for science education.

Technology in the educational field was thought of as a means of transmitting information, which gave a passive role to the student. However, today they are considered as knowledge management tools that improve learning and make it meaningful for students, as they facilitate the exchange of scientific information, allow access to various content, collaboration and synchronous and asynchronous communication with teachers in learning environments for the construction of knowledge through understanding, creativity and innovation (Ruiz et al., 2014).

Hybrid education is a mixed model that combines face-to-face and virtual education through different media, such as online learning platforms (Viñas, 2021). However, Fullan et al. (2020) believe that rather than distributing tasks between one modality and the other, it is necessary to rethink education and develop teaching and learning models that capture the attention and interest of students to learn in different ways in each of these modalities. Technology should be used as mediation for learning rather than as a channel for transmitting content in which priority is given to developing collaborative skills among students, both face-to-face and virtual. Therefore, the creation of hybrid learning environments seeks to converge two modes of learning: “face-to-face” learning and “distributed” learning, supported by technology (Osorio, 2011).

In this direction, it is clarified that a learning technology platform is a set of hardware, software and support services necessary for the training activity in an integrated system that opens new training environments concerning traditional educational models (Prada et al., 2019). Many of these platforms rely on Moodle as a learning management system (LMS) and course management system (CMS) for the development of a learning community, which has a set of tools to implement online courses through collaborative activities and tools such as forums, wikis, glossaries, database activities and much more (Sánchez et al., 2012).

On the other hand, the didactics of natural sciences have as their object of study the teaching-learning process, the contents related to systems and physical, chemical and biological changes that take place in the universe, taking into consideration the place of man in the nature-society relationship (Prieto & Sánchez, 2019). Therefore, knowing how to teach science in the digital era proposes finding new ways for a more dynamic and participatory pedagogical process to prepare students to understand and live in the globalization that today's world tends (Arteaga et al., 2016).

Science education requires major changes in its teaching and learning models so that students reach the standards expected through training processes and skills related to managing scientific knowledge in their daily lives (Santafé, 2017). Therefore, for science teaching, the teacher must leave the traditional exposure to content and start from the student's previous experience through strategies based on developing their cognitive skills and ability to process information.

It is known that the use of ICT does not imply an improvement in teaching processes, and there is even a risk that, depending on how technology is incorporated, it may mean a return to more traditional or transmissive pedagogical approaches. Therefore, the challenge is understanding what role these tools can have in bringing real added value to science classes. Some elements of scientific practice that take on special relevance when some ICT is introduced in the science classroom have to do with ICT for data collection and experimental analysis of real and virtual phenomena, the expression of models with digital support, argumentation and communication in the science classroom (López et al., 2017).

METHODOLOGY

Research design

The research was developed under a quantitative, descriptive, cross-sectional approach and a field design.

Target population

A finite population was determined, made up of teachers of natural sciences at the middle school level belonging to educational institutions located in Norte de Santander, Colombia, selected on a non-probabilistic basis. Therefore, 32 teachers were selected as a sample, 20 of the male gender and 12 of the female gender. The information was collected directly in the context of the study.

Collection of information and procedure.

In the study, a questionnaire was designed with two sections. The first included the age and gender of the teacher, time dedicated to teaching, and use of ICT, among others, and the second consisted of 17 closed items to determine their perceptions on the use of ICT and strategies for science teaching, both in face-to-face and non-face-to-face spaces. The options offered were established using a Likert scale with 3 response options, No (0), Sometimes (1) and Yes (2).

For validity, a panel of three expert judges in survey construction was used to determine the items' relevance, sequence and length. Next, a pilot test was carried out with a sample of subjects common to the sample to identify possible shortcomings in the survey preparation. The reliability analysis yielded a satisfactory value (Cronbach's alpha of 0.9), indicating adequate internal consistency of the survey; therefore, the instrument is homogeneous and valid. Once these processes were completed, the final version of the instrument was obtained and administered virtually to the teachers using a Google Form.

Information analysis

Once the information was collected, it was represented in tables using SPSS V.25 and Microsoft Excel. Finally, the data analysis was carried out using statistical tools, which allowed the teachers' perceptions regarding using technological tools according to the hybrid modality in secondary education.

RESULTS

The analysis was carried out under an analytical approach around the study variables and those intervening variables to know teachers' perceptions regarding the use of technological tools according to the hybrid modality in secondary education.

Next, we detail and analyze the results obtained in aspects such as the use of ICT in the classroom and the tools of the virtual platform for teaching science in section 1 of the questionnaire, and the teaching-learning strategies used in science classes and knowledge and use of technological devices and the technological platform in non-face-to-face classes in section 2.

Using ICT in the classroom and virtual platform tools for teaching natural sciences.

This section illustrates the use of ICT in the science classroom (Table 1) and the use of tools, mainly the virtual platform (Table 2), used by teachers. .

Table 1. Use of ICT in the natural sciences classroom.

Use of ICT	%*
Presentation of topics	62,2
Problem-solving and simulation	17,5
Data processing.	15,4
Information search.	14,8
Other uses	1,9

* The sum of the percentages may exceed 100%, because the teacher may consider more than one use.

Table 1 shows that mostly (62.2%) ICT is used for the presentation of science topics, followed by problem-solving and simulations (17.5%) for certain situations associated with the topic to be developed. The teacher uses video presentations as a complementary resource in developing a theoretical class, which implies using technology as a traditional or transmissive pedagogical approach (López et al., 2017).

Table 2. Virtual platform tools

Tool	%*
Chat	31,3%
Forum	23,8%
Questionnaire	16,5%
Tasks	13,5%
Inquiries	11,5%
Blog	9,3%
None	6,3%

* The sum of the percentages may exceed 100% because the teacher may consider more than one use.

Likewise, according to Table 2, chat is the most used tool (31.3%). Another tool used by teachers is the forums (23.8%). Finally, another tool frequently used by teachers but not part of the virtual platform is e-mail. However, the above evidences the use of these tools only as forms of virtual communication (Bertazzi et al., 2010), missing the possibility of using tools such as chat, recording what is being written on a given topic, and, probing the students' prior knowledge regarding a topic. This allows the exchange

of information between classmates and the teacher and the forum to promote learning processes and critical thinking through inquiry, negotiation and knowledge construction (Nájar et al., 2014).

Teaching-learning strategies used in science classes

This part of section 2 of the questionnaire seeks to identify the teaching and learning strategies teachers use in class for teaching natural sciences (Table 3).

Table 3. Teaching-learning strategies used in science classes 19.

Items		No	Sometimes	Yes
		%	%	%
Theoretical classes	Uses theoretical exposition as a teaching and learning strategy 2.	0,0%	100,0%	0,0%
	2. Assigns greater importance to conceptual content.	0,0%	100,0%	0,0%
	3. Achieves compliance with the proposed objectives through the strategies used.	0,0%	0,0%	100,0%
	4. Considers conceptual management as a priority for the teaching and learning of science.	0,0%	0,0%	100,0%
Troubleshooting	5. Reinforces teaching and learning by using problem solving.	0,0%	100,0%	0,0%
	6. The problems to be solved in the classroom, outside the classroom, and evaluation are related to real everyday situations.	0,0%	100,0%	0,0%
Laboratory, simulations and learning achievements	7. Uses demonstration of physical phenomena in the laboratory to facilitate understanding of the subject matter.	0,0%	37,5%	62,5%
	8. Students gain an understanding of physical phenomena through theoretical lectures.	0,0%	100,0%	0,0%
	9. Students satisfactorily solve the problems posed.	0,0%	100,0%	0,0%
	10. Students are able to identify the physical phenomena demonstrated to them.	100,0%	0,0%	0,0%

According to Table 3, for the theoretical classes, it was evidenced that in items 1 and 2, 100% of the teachers sometimes use theoretical exposition as the only technique and assign greater importance to conceptual contents. Concerning items 3 and 4, 100% of the teachers considered that they achieved the

proposed objectives through the strategies used, and considered conceptual management a priority for teaching the subject in the area of science. When contrasting the results, it was evidenced that teachers continue to teach their theoretical classes in a traditional expository manner, whose technique is transmission-repetition; the classes are limited to providing the information contained in the curricular planning (Acosta & García, 2012). In opposition to the above, the success of classes, in this case of natural sciences, depends largely on the use of contemporary active didactics such as problem-based learning, research seminar, evidence-based teaching, project method, tutorial method, case studies, personalized teaching, simulation and games, among others (Legarda-López, 2021), which can be complemented with the use of ICT and which allow the creation of educational environments and situations that promote active learning (Prada et al., 2021).

Regarding problem-solving in the classroom, in items 5 and 6, 100% of the teachers surveyed indicated that sometimes they reinforce teaching-learning using problem-solving and the approaches to solve problems are related to real situations. However, it seems that this does not favor the development of scientific skills and competencies in students, such as the explanation of phenomena, the use of knowledge and inquiry (Salamanca-Meneses, & Hernández-Suárez, 2018).

Regarding item 7, it was verified that 62.5% of the teachers demonstrate physical phenomena in the laboratory to facilitate the understanding of the subject, while 37.5% indicate that they sometimes do so. However, it is noteworthy that the educational institutions under study have a very basic infrastructure of science laboratories, so many of the demonstrations, when done, take place in the classroom. Therefore, changes in the teaching-learning models of science are required to develop and apply important ideas (principles and laws) that explain a wide field of phenomena through educational training processes and skills related to scientific knowledge management in their daily lives (Santafé, 2017).

Finally, for items 8 and 9, 100% of science teachers sometimes perceive that students manage to understand physical phenomena with only theoretical lectures and that they satisfactorily solve the problems posed. For item 10, 100% of teachers do not believe that their students can identify physical phenomena demonstrated to them. These results oppose the approach of Acosta & García (2012). Instead, they maintain the idea that teaching strategies should provide scaffolding to the constructive activity of students in the means or resources used by the teacher to elicit learning and encourage students through innovation in strategies for a meaningful construction that can serve in the resolution of activities (Gómez-Valderrama & Ramírez-Sánchez, 2017).

Knowledge and use of technological devices and the technological platform in non-face-to-face classes is analyzed in the second section of section 2 of the questionnaire, corresponding to identifying the ICTs used by teachers for teaching natural sciences (Table 4).

Table 4. Knowledge and use of technological devices and the technological platform in non-face-to-face classes.

	Items	No	Sometimes	Yes
		%	%	%
Knowledge and use of technological devices in face-to-face classes.	11. Knows how to operate and use technological devices such as computers, tablets, and cell phones.	0,0%	0,0%	100,0%
	12. Knows and uses programs and applications to develop thematic content in	37,5%	12,5%	50,0%

	the teaching and learning of natural sciences.			
Knowledge and use of the virtual platform for non-classroom classes.	13. Knows the technological platform of the institution	25,0%	0,0%	75,0%
	14. Knows how to use the technological platform of the institution	37,5%	25,0%	37,5%
	15. Has been able to use technological devices to develop non-face-to-face classes.	62,5%	12,5%	25,0%
	16. Consider the technological platform suitable for non-face-to-face classes.	12,5%	12,5%	75,0%
Hybrid learning environment	17. Considers the hybrid modality adequate for teaching and learning natural sciences.	25,0%	0,0%	75,0%

In Table 4, items 11 and 12, we analyze natural science teachers' knowledge about the technological devices they use. In item 11, 100% of the teachers express that they do know the operation and use of technological devices such as computers, tablets and cell phones, but not for pedagogical use, since in item 12, it is asked if they know programs and applications for teaching natural sciences, where only half express that they do, while 37.5% do not know and do not use these tools for the development of their classes. According to the above, it is evident that teachers are unaware of the existence of programs and applications that would help them to complement their pedagogical activity, especially for simulations and laboratory practices, since they do not have adequate criteria for the selection of technology but resort to it to develop support material for traditional classes (Rivero et al., 2013). That is, they do not use ICT for tasks that involve approaching knowledge, and this is due, on the one hand, to their lack of knowledge and use, and on the other, to the lack of adequate curriculum planning according to the achievements, indicators and contents of natural sciences, which does not generate classroom environments to generate meaningful learning (Hernández-Suárez et al., 2021).

Likewise, items 13 and 14 show the data related to the teacher's knowledge of the technological platform. It was determined that 75% of teachers do not know it and only 37.5% express that they know how to use the platform. This affects the social constructivist teaching and learning processes (Reyero, 2019) since the technological platform is only used to transmit information (Montes, 2007). On the other hand, in item 15, 62.5% of the teachers indicate that they do not use technological devices to support the students' non-face-to-face classes, but 75% consider that the virtual platform is adequate for this training.

Finally, item 17 asks whether face-to-face and non-face-to-face learning combined in a hybrid environment is adequate for the teaching and learning thematic content in natural sciences, obtaining that 75% consider it so.

The results indicate that not all teachers understand the importance of using the virtual platform as a complement to face-to-face classes since, although the pandemic accelerated a process that inexorably had to occur and that rethought the way of teaching the use of ICT (Crosetti et al., 2021), some teachers did not manage to adapt the technology, which limited its pedagogical use to generate true interactive learning environments (Medina-Gual et al., 2021), and what they did was to transfer the traditional face-to-face teaching model to a remote one (Hernández et al., 2022).

The pandemic has highlighted the need for back-to-school to continue with processes of flexibility and

to rely on more resources for interaction between students and teachers beyond the face-to-face classroom (Torres et al., 2022), and a hybridization is a viable option within the variations that occur in pedagogical relationships (Plá et al., 2020), freeing teachers and students from the limitations of time and space, and offering greater flexibility in individual or group learning opportunities, as well as a learning space, through the encounter and interaction in which subjects support each other (Gómez-Valderrama et al., 2020) necessary for the creation of hybrid learning environments (Osorio, 2011).

CONCLUSIONS

Natural science teachers tend to use traditional theoretical classes, although they use problem-solving, demonstrations and laboratories on physical phenomena; this is done occasionally because the educational institutions do not have the good infrastructure and materials necessary to carry out these activities. Therefore, their face-to-face activities are focused on lectures and students partially acquire the concepts for problem-solving and recognition of physical phenomena. Likewise, despite basic mastery of certain technological devices, they only occasionally incorporate them into classroom activities. In addition, some teachers are unaware of the existence of programs and applications that would help them to complement their pedagogical activity, especially for simulations and laboratory practices. Finally, very few use technological resources such as educational platform, which helps promote hybrid learning environments.

This study can be a starting point for future studies that are responsible for demonstrating the incidence of hybrid learning environments with experimental studies at the classroom, area or educational level, as well as comparative studies between public and private institutions to determine whether social, technical and technological variables influence the creation of these environments or whether it is a matter of other variables not contemplated.

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