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THE INNOVATIVE POTENTIAL OF ICTS IN THE LEARNING OF MATHEMATICAL CONTENTS FROM THE USE OF PHOTOMATH

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ABSTRACT

This article seeks to discuss the use of ICT in the teaching-learning process of mathematics at university using mobile technologies (smartphones) as a didactic resource for learning mathematical content. It aims to analyze the students' perceptions regarding the use of ICT in their learning using the Photomath application. The exploratory study performed with students in the Calculus discipline showed that 100% of students claim to use mobile technologies for study purposes. They indicated the advantages of convenience and easy access to information and identified the disadvantages of digital content with low methodological focus, dispersion, and health problems. Of these, 90% affirm that most teachers do not use ICT in the classroom engaged in student learning and that those who do it use applications, social media, and educational games. Although they are incorporated into the students' daily lives and help the development of their skills, ICTs face difficulties in being incorporated into their learning process. This study reaffirms the importance of teaching mediation during the use of ICT to learning mathematical content by the students. To that end, it still requires more investments in an epistemology of practice that assumes ICT and its relationship with learning as an object of research.

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INTRODUCTION

The development of Information and Communication Technologies (ICT) provoked a revolution in the communication world due to the emergence of multimedia devices and telematic networks (Delors, 2001). These technologies have been incorporated into the daily lives of cognizant subjects in today's alleged knowledge society in a natural and naturalized manner (Pozo, 2002).

However, this incorporation seldom occurs at the same speed in the teaching-learning process at the university since changes in education are traditionally slower when compared to the fast pace of society (Coll; Illera, 2010). Likewise, the inclusion of ICT in teaching practices is slow and often does not occur critically. The great quantity of information made available and the processing speed of these new practices, when paired with the short lifespan attributed to knowledge, hinder individuals' efforts to better understand and reflect on the use of these technologies. Nevertheless, ICT can have a potential in the reconfiguration of knowledge and actions of university teaching in the face of the challenges brought by students. Challenges ensued from the possibility of access they have to information that allows the teacher to move from the place of a sole holder of knowledge to where he is questioned and instigated to change. Challenges that can only be understood when confronted with the complexity of teaching practices as evidenced in research (Soares, Cunha, 2010; Garcia, 1999), as they demand the mastery of a multiplicity of knowledge, competence, and outlook, and implies dealing with both the cognitive dimension and the affective-emotional dimension to consider the skills, attitudes and values of the subjects involved. Faced with these demands, the university professor feels insecure and challenged, in his role as mediator, to seek attempts to overcome these problems by innovative pedagogical practices.

For Cunha (2004), innovative pedagogical practices can be any experiences that sever with traditional methods, eminently transmissive and segmented, and go beyond the processes of reproduction. Still, this is a slow cultural process, which does not necessarily occur at the time of vertiginous scientific and technological advances, much less is it due only to the researcher's or teacher's desire. Hence why it is necessary to have patience and be willing to investigate to accompany changes in the ways of thinking and teaching involving ICT, a condition that becomes structural for the development of innovative pedagogical actions. From this point of view, we start from the premise that adding 'technology in schools and classrooms, without altering the usual teaching practices, does not [necessarily] produce good results in student learning' (Miranda, 2007, p. 44).

The use of ICT in a more or less innovative way depends on teaching mediation, which is in turn linked to a series of factors, such as the technical-pedagogical training of educators, their technological support, conceptions and expectations about the educational value of ICT and pedagogical planning and of what it means to teach and learn (Coll; Monero, 2010). In this sense, "[...] the incorporation of ICTs in classrooms opens the way for pedagogical and didactic innovation and for the search for new ways to improve teaching and promote learning [...]" (Coll; Illera, 2010, p. 289).

And it is in this context of challenges that the teaching of mathematics at the university is inserted and often perceived abstractly, its concepts conveyed as absolute and immutable truths, and little applied to the student's reality and interests. Therefore, it is understandable that some students are apathetic, disinterested, and unmotivated, presenting low performance in exams. It remains to be seen how the teacher, through ICT and innovative practices, seeks to face and overcome these problems.

This article seeks to reflect on how university students on an Information Systems' graduation course perceive relationships between ICT and learning from the use of an application Photomath. To this end, its objective is to analyze the students' perceptions on the use of ICT in their learning, specifically about the smartphone application Photomath, available for IOS and Android systems. Photomath's function is to solve mathematical calculations addressing content ranging from basic education to graduation. In accordance to the United Nations Educational, Scientific and Cultural Organization (UNESCO), we consider the smartphone as a mobile technology that consists of any digital and portable device 'owned and controlled by an individual and not an institution, capable of accessing the internet and multimedia aspects and can facilitate a large number of tasks, particularly those related to communication' (UNESCO, 2014, p. 8).

METHODOLOGY

The study was developed through a descriptive investigation, which aims to describe an event, a phenomenon, or a fact. Therefore, it proposes to describe a particular population or phenomenon or to establish relationships between variables (Gil, 2010). With a quanti-qualitative approach chosen for the research, the students' responded to a questionnaire with objective and subjective questions prepared by the authors and made available to participants online through the Google Forms tool. The purpose of this questionnaire was to make explicit the students' ideas related to the use of ICT and the learning of mathematics content in a public university.

The questionnaire, a data collection instrument, was applied to all students regularly enrolled in the Calculus discipline of the bachelor's degree course in Information Systems and counted on the participation of all 10 (ten) students voluntarily. Since the testimonies are analyzed based on Bardin's content analysis (1977, p.42), the content analysis comprises:

> A set of communication analysis techniques aiming to obtain, by systematic and objective procedures of describing the content of the messages, indicators (quantitative or not) that allow the inference of knowledge related to the production/reception conditions (inferred variables) of these messages.

From the data, we sought to raise categories that made it possible to discuss relationships between the use of mobile technologies and the learning of mathematical content, with the main focus on the use of the Photomath application.

RESULTS AND DISCUSSION

The perspective of use and assessment of the advantages and disadvantages of ICT by the students.

Data shows that 100% of the students claim to use mobile technologies for educational purposes. Nowadays, this is understandable as 'a large number of students are increasingly using their smartphones to communicate while studying' (Borba, Silva, Gadanidis, 2018, p.81). In addition to that, they are students with higher education, and many already work and can purchase a mobile device. The smartphone is the mobile technological device that the majority, around 70%, use for study purposes, according to the respondents.

For Borba et al. (2018), mobile technology, such as smartphones, has become considerably popular in recent years. Many of our students use the internet in the classroom through cell phones to access platforms like Google and applications, cameras, or video to record moments of classes. The use of these technologies tends to shape the classroom, creating dynamics, transforming collective intelligence, power relations, and the norms to be followed in that same classroom (Borba et al. 2018).

When asked about the advantages of using these mobile technologies, students emphasize: ease of access to content, convenience, optimization of time, or, as one of the participants explains, the "possibility of using the internet for quick searches without the need for a wi-fi network, using only mobile data." As evidenced, students evaluate ICTs based on their real needs as consumers. Although they reveal the importance and influence of ICT in the ways of acting and thinking, developing personal skills and competencies, these aspects are not directly related to the phenomenon of how they learn.

However, one of the students considers the "validation and correction of exercises proposed in class" to be an advantage, which may reveal the potential that these ICTs offer through a vast range of options and resources to improve existing practices and outline others. This allows the introduction of

new forms of mediation between the student and the learning content (multimedia and hypermedia materials, simulations, etcetera); between the teacher and these contents (databases, directories, archives of open educational practices, etc.); between teacher and student and among the students themselves (distance communication, communities of interest, etc.); as well as between the actions of the teacher and the student and the contents and tasks, such as: requesting, providing and exchanging information and asking, giving and receiving feedback and help, among others (Coll, 2009). In this respect, this still seems to be a dimension to be achieved in the classroom by the parts involved.

Investing in the use of ICT in education can only work through the hands of teachers, according to Demo (2008), since what transforms technology into learning is not the computer, notebook, electronic program, or software, but the teacher in his 'Socratic condition'. This impacts on the way the teacher will appropriate these technological resources to 'create methodological projects that surpass the reproduction of knowledge and lead to the production of knowledge' (Behrens, 2000, p. 103).

As for disadvantages of using these mobile technologies, students reveal the existence of digital content with a low methodological focus; possible dispersions during study sessions, since "using the smartphone to study I am subject to distractions, like WhatsApp'; in addition to realizing the possibility of acquiring 'health problems over time".

As evinced, students are concerned about the effects of using the smartphone both for their learning and their health. Phenomena such as distraction at work or study due to the use of social networks, dependence on Google's virtual memory, social isolation, spinal problems, hearing loss, and addictions to virtual games are some of the conditions indicated by the testimonies of the participants. According to King, Nardi and Cardoso (2014), the excessive use of the smartphone starts to cause behavioral and emotional changes and signs similar to those presented by drug users in individuals, which therefore demonstrates the harmful effects that technological dependence can cause.

Thus, currently, it is necessary to reflect on this issue, mainly in bachelor's degrees in Information Systems, and to incorporate disciplines or content that address this concern; a commitment to the training of the citizen-worker that goes beyond the perspective of technical and instrumental training.

3.2 About the articulation between ICT and the teaching-learning process.

When asked about where they use mobile technology most for educational purposes, most students, 80%, claim to use it at home, with 10% using it at the university outside class hours and 10% anywhere possible. These data lead us to believe that ICT still finds it difficult to reach the classroom in an integrated way in the learning process. The students reaffirmed this fact in the following question when asked whether the teacher used mobile technologies in the classroom. For 90% of students, the majority of their teachers do not use ICT in the classroom to improve their learning.

This fact may even be understandable since the study of ICT in each course does not necessarily mean its use for educational purposes. For Coll (2009), the use of technologies alone does not represent a change in pedagogical practice if they are used only as technological support for illustration in class. Therefore, its use as a tool to mediate learning is necessary for the improvement of the teaching-learning process. At the same time, this becomes a contradiction once the teacher is challenged not only to teach specific content but also to provide favorable conditions for student learning. This transition, which shifts the focus from teaching to learning, is a challenge that indicates to the university the need to review the continuing education of teachers, their performance in the teaching-learning process, as well as a postgraduate policy that encompasses reflection on the practice itself as a condition for knowledge production.

It is possible to see that, despite all the discourse in research to accept the importance of ICT in education, they still have difficulties to be incorporated as pedagogical tools and to produce changes in a teaching culture based exclusively on the transmission of content. It is important to note that this difficulty of incorporating ICT into formal education manifested by students occurs even in training courses for professionals in the information technology area. According to Moran (2009), such aspects can be explained by some teachers' difficulties or lack of interest in directing these technologies towards pedagogical benefits, the lack of institutional conditions for their implementation, and an education culture centered on the transmission of the information at the expense of constructive processes with students that lead to meaningful learning.

Regarding the technologies most used by teachers in the classroom, some students specify the use of applications (Photomath, Geogebra, Winplot, Data Structure Visualizations, HP-12C financial calculator), social networks (WhatsApp), educational games (Kahoot) or video platforms (Youtube). Although often regarded from an instrumental perspective in higher education and not always effective in articulating with the learning of specific content, these technologies certainly contribute to the development of broader skills and competencies in students (Pozo and Echeverría, 2009), which go beyond the strategy of pure and simple transmission of content. They make it possible to develop the student's autonomy to seek and select information, among other skills that act as adjuvants to the teaching-learning process.

3.3 Analysis of the use of the PHOTOMATH application in the learning of mathematical content

Initially, when asked if they knew the Photomath application, 90% of the participants said yes, and of these, approximately 78% claim to use the application. All students who use the application consider that it favored the learning of math content. Among the most cited facilitating reasons, we have: to show the step by step of resolving the issue, the possibility of identifying your error, submit different resolutions, and the application's functionality to capture the exercise through photography and make the resolution process more dynamic and faster. The following were also mentioned: assistance to answer questions, to understand the content and explanation of the most basic steps. As we can see in this report:

> It made it a lot easier since in my case, one of the biggest difficulties in the study of mathematics is the fact that

> when I find a sequence of questions that I do not understand the resolution, I give up to continue with the study to clear up the doubts in the classroom, making one subject "run over" the other. With Photomath and its options showing a step-by-step solution, the recurrence of this problem is greatly reduced. (Participant 1).

As explained, one of the challenges for the teaching of mathematics in the training of professionals is to teach how to learn, to think, to reflect on the contents, and to seek different solutions, which goes beyond pure and simple reproduction of problem-solving. Differentiating exercise problems seems to be the first step in facing this situation. For Pozo and Echeverria (2009, p. 47), exercises can seem like "the most complicated tasks in terms of new knowledge and experience, but we know how we must confront them and solve them." To overcome this perspective means to use resources that make it possible to learn to understand and solve problem situations, to go beyond a concept of solving exercises structured from knowledge acquired and applied in a routine and repetitive way to questions whose answers are known.

From these results, it is feasible to see that the use of Photomath, depending on the mediation performed by the teacher, can enhance actions to work with error, with doubt and uncertainty, motivating and stimulating meaningful learning and self-learning. In these new times, this mediation demands a conscious use of ICT that can articulate teaching and research, contribute to the development of reflective thinking and of the ability to solve complex problems autonomously, leading the student to be able to face and solve problem-situations, including those resulting from professional practice. This mediation can incorporate unusual situations into teaching that have the potential to generate cognitive imbalances and may occur in their professional future. From contacting these circumstances while still at the university, the students can develop skills to act and make decisions reflexively and critically in their professional future.

Nonetheless, one of the participants revealed that the application has some imperfections in its use, which means limitations concerning specific cases of problem situations:

> Yes and no. Yes, because in fact, Photomath shows everything step-by-step, provides an explanation, and even allows you to address other ways of visualizing the same problem situation. However, because it is still very limited and does not have functionality for specific cases of a problem situation, it can be problematic. It is as if the student needed to ask a question and supposing that he uses the application as his main medium, he lacks that answer and it makes a big difference in his performance. Besides, the step-by-step of Photomath's responses, despite being explained, does not usually have alternative writing and ends up being highly formalized. Some step-by-steps are also visually poorly signposted, which leaves you a little confused. (P2)

Therefore, the student's testimony reaffirms the previous discussion on the importance and the need for teacher mediation in the scrutiny of the application's potential to build meaningful learning, including to propose improvements to its developers. This aspect is in line with Carvalho's statement (2015) of the need to conduct more research that explores the didactic potential of applications available on the web. For that, it becomes important for the university professor to adopt an investigative and participative stance in the construction of critical knowledge that induces changes in resources or in their use. This construction will not arise from the resources, but with them through an interaction with the students based on an epistemology of practice, in which the teacher, individually or collectively, produces knowledge about each singular reality of teaching situations and socializes it.

On the other hand, it is imperative to mention that this burden cannot fall only on the shoulders of these higher education workers, who often did not have pedagogical theoretical-methodological knowledge in their initial training, and even less preparation during their postgraduate studies for research that promotes reflection on the very practice of teaching and learning at the university (Soares; Cunha, 2010). That is why it becomes important for the university to assume the political commitment to qualify, stimulate and evaluate the professor and the reflexive professor-researcher who produces knowledge about their own practice, as well as for the research promotion agencies to incorporate this need in the researcher's training. A training unrestricted to a transmissive, heteronomous, and distant perspective of professional practice, but meaningful to the teacher and outlined based on his concrete needs. Unfortunately, the disregard for research and higher education shown through divestments made in recent years, as a result of neoliberal policies, points to the need to intensify collective and institutional struggles as an effort to guarantee the reversal of this situation at universities.

CONCLUSION

One of the requirements of contemporary society is the incorporation of ICTs into individuals' modus operandi, often uncritically and instrumentally. In this article, we sought to analyze the perception of Information Systems students regarding the use of ICT in the learning process, specifically with the use of the Photomath application, whose function is to assist in solving mathematical calculations.

In this work, it is evident that all students in the course use mobile technologies, mainly in the form of smartphones, for study purposes. However, most university teachers do not use these ICTs in the classroom for learning. Such evidence, in addition to reaffirming that technologies are incorporated into the teaching-learning process much more slowly than what occurs in society, also reveals the importance of teaching mediation in the appropriation of these resources and their use aimed at learning in a constructivist perspective of teaching (Coll, 2009).

It is also noticeable that the majority of students know the Photomath application, of which 78% use it and consider that it facilitates the learning of mathematical content since it makes it possible to clarify doubts, solve the problem step-by-step and identify errors. To use these resources and to interfere in their construction and improvement, based on knowledge built during the practice itself, seems to be the teacher's challenge, in the sense of overcoming the limits of using ICT in an eminently uncritical and instrumental perspective, along with seizing the leading role in the mediation and knowledge production aimed at student learning.

To face this challenge means to enhance the use of ICT to work with error, doubt, and uncertainty, with problems or

problem situations instead of exercises applied in a routine and repetitive manner whose answers are known, therefore contributing to the development of the scientific spirit and reflective thinking of the student and building skills and competencies that lead to their autonomy to face and solve future challenges as a citizen and professional. A challenge for the university in continuing education for teachers and for a postgraduate policy that encourages reflective and investigative processes about their own practice.

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