

Technological Mediation from Didactic Principles in Virtual Graduate Students: A Case Study in Mexico

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Abstract: Information and Communication Technologies (ICT) have increased considerably in different areas of human life, and education is no exception. In particular, educational offerings have diversified, mainly at the levels of Higher Education, in virtual and distance modalities, allowing people to organize their time for work, study, and family and continue with their education. The objective of this study was to identify the perception of virtual graduate students mediated by technology from the didactic principles in their teaching-learning process. A quantitative methodology was used, an exploratory, descriptive cross-sectional study was carried out using a non-experimental design, working with the survey method, and a questionnaire was applied to 281 virtual graduate students. Among the findings, a positive perception of the use of didactic principles in the teaching-learning process was identified based on the development of individualization, activity, creativity, autonomy, play, and motivation. The results recommend enriching the processes of socialization and interaction among group mates since most of the activities are carried out individually.

Key-words: didactic principles; postgraduate; mediation; technology; virtuality.

1. Introduction

Today's society is characterized by the continuous and accelerated changes that occur in different contexts; what is new today ceases to be new very quickly (González & Esteban, 2013; Díaz-Barriga, 2013; Lindgren,

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2021). Information and Communication Technologies (ICT) and digitizing all information and communications have greatly influenced any area of human life (Mañero-Contreras, 2016; Gómez Galán, 2020; Burrell & Fourcade, 2021). They have modified the way of relating and the communicative processes both synchronously and asynchronously; it has blurred the space-time barriers (Sánchez & Vera, 2016, Ajabshir, 2019; Ordaz & González, 2019), which generates a dynamic that demands new ways of living, of acting, that demand better organization, and training not only for life, but throughout life (Alvarado, 2014; Voitovska & Tolochko, 2019; Eynon & Malmberg, 2021).

The massification of means of communication from the use of the Internet, digitalization processes, and the management of different technological resources and web applications (chat, email, online forums, wikis, social networks, blogs) are evident in other areas. Education is no exception (González & Margallo, 2013), which has allowed working from new formats, expanded the times and spaces, and improved teaching-learning models in both formal, non-formal, and informal areas (Nygren et al., 2019; López-Meneses, 2020).

However, it is essential to reflect that the use of ICT alone does not guarantee progress toward learning; it is necessary to design changes that allow the transition from an Information Society to a Knowledge Society (González & Margallo, 2013, Puerta et al., 2020) where conceptual knowledge (knowledge, theories, and laws), procedural knowledge (skills and abilities), as well as attitudinal knowledge (interests, motives, and modes of action) are mobilized. The competencies of Higher Education teachers and students in digital technologies are fundamental today (Concepción et al., 2019; Veytia et al., 2019; Gómez-Galán et al., 2021; Jorge-Vázquez et al., 2021).

In general, using technological tools as alternatives to design pedagogical strategies (Rivero, Gómez & Abrego, 2013) that favor the construction of conceptual, procedural, and attitudinal knowledge in students both individually and collaboratively (Durán-Medina & Durán-Valero, 2018) and in which the subject develops the ability, for example, to identify information, use it in specific contexts, interact with that information, is today one of the challenges of the university. In addition, that allows teachers and students to increase the alternatives to face the challenges presented to them in the different spaces in which they develop and face multiple problems.

Specifically, the incorporation of ICT in educational contexts has increased considerably (Díaz-Barriga, 2013), and Virtual Learning Environments and Environments offer the opportunity to strengthen the development of cognitive operations such as interpreting, questioning, reflecting, debating, discussing ideas and points of view (De Agostini, 2013). In addition to the fact that the use of ICT strengthens learning to learn

permanently and autonomously (Infante, 2014; Boykov & Goceva, 2019) by generating necessary aids in students such as: 1) communicating and clarifying teaching activities, 2) planning teaching-learning processes, 3) providing better and more current contents, 4) having more solid support for the construction of knowledge, 5) working a more horizontal communication between teachers and students (Monereo, 2005).

Higher Education faces several challenges when using ICT in the teaching-learning process since it is necessary to rethink education in such a way that it links the academic field with the labor field, as well as to respond to the constant challenges identified in the society of the 21st century (Romero et al., 2014). The transition from a teaching society to a learning society (Arroyave, Arias & Gutiérrez, 2011) allows building intersubjective relationships, knowledge, skills, abilities, and skills for the use of technological tools as a means for the development of thinking skills, in addition to the fact that an Information Society that transitions to knowledge and learning continuous demand learning throughout life (Juca, 2016; English & Mayo, 2019).

2. Scientific Literature Review

The use of Information and Communication Technologies in Higher Education has allowed strengthening different modalities (García & Pineda, 2011; Fernández, 2016) that are sometimes handled as synonyms in various texts, however, it is essential to specify the features that characterize each of them, Distance Education arises before the use of ICT, the sending of materials by correspondence or physical delivery in educational institutions, where students have the opportunity to learn at their own pace to meet the established objectives, Virtual Education is mainly based on the binomial technology/education (Alvarado, 2014), students use ICT to download their materials and upload their activities and tasks, however, it is not necessary to coincide in a specific time with their classmates and teachers, finally Online Education is based on the use of different technological tools for the development of activities and tasks, in addition to coinciding in a specific schedule with their teachers and classmates for the completion of their classes (Saltmarsh & Stherland-Smith, 2010).

One of the characteristics of Distance, Virtual, and Online Education is the realization of asynchronous work, which provides a flexible space (Peñalosa, 2010), placing both students and teachers in an active role since it allows the completion of activities and tasks at any time and from any device with internet access (Kurtz & Sponder, 2010; Morado & Ocampo 2019, Perazzo, 2000), it generates spaces for interaction and research among the learning community (Flechas & Juárez, 2017), it offers access opportunities to groups that find it challenging to attend educational institutions in person,

either because of distance or because they divide their time between study and work (Nieto, 2012), it crosses any barriers (Arroyave, Arias & Gutiérrez, 2011) which allows enrollment in universities located in other parts of the world (Goldín, Kriscautzky & Perelman, 2013).

When analyzing Higher Education in its Distance, Virtual and Online modalities from a critical point of view, it is pertinent to reflect on the didactic design of the courses, as well as the needs that arise from the use of various technological tools, and thus consider the didactic principles that are present in the teaching-learning process based on instructional design (Fernández, 2016; Savard, Bourdeau & Paquette, 2020; Kale, Roy & Yuan, 2020). Yuan, 2020), since sometimes there is a more significant concern for the use of the technological medium and the didactic-pedagogical foundation is neglected, or proposals are presented with a weak approach to work them (Díaz-Barriga, 2013), where sometimes the blackboard is replaced by the digital whiteboard. However, the traditional teaching-learning process based on a vertical perspective in which the teacher transmits knowledge mainly from an expository methodology continues; it is necessary to move to a horizontal paradigm where a learning community is configured where each of its members has something to learn and something to contribute, so it cannot be considered that the increase in technology is necessarily proportional to the increase in educational quality (Escueta et al., 2020).

Rather than seeing technologies as a resource that supports the didactic part, they should be considered as one that strengthens the development of capabilities, as well as the versatility for the construction of knowledge (Vargas & Jiménez, 2013; Bouton, Tal & Asterhan, 2021); breaking with the paradigms that limit the ways of teaching and learning and considering the development of skills to coexist in virtual environments (Asterhan, 2021) fails with the paradigms that specify the teaching and learning methods and feels the development of skills to coexist in virtual environments. Nevertheless, it is a complex process (Flechas & Juárez, 2017) to generate a change of dynamics between the didactic triangle formed by teachers, students, and knowledge mediated by technology.

Regarding the trends in the incorporation of Information and Communication Technologies in education, Díaz Barriga (2013) mentions three main ones: (a) those that consider enabling teachers to use different technological programs; (b) those that are oriented to develop contents that can be presented online through different digital materials; and (c) those that seek the incorporation of ICT in the classroom from a perspective in which didactic principles are taken into account.

García-Aretio (2016) recovers a series of didactic principles that have been used in face-to-face spaces and that are currently still valid in the teaching-learning processes that are carried out from technological mediation, which are listed below:

Individualization: Each human being is unique and unrepeatable; it is, therefore, essential to consider the individual characteristics of the subjects, the processes of assimilation, accommodation, balance, imbalance, and rebalance (Piaget, 2001), the experiences, personal characteristics, aptitudes, attitudes, interests, scope and limitations to be adapted to the teaching-learning process. The importance of individualized attention respecting each subject's learning styles and pace (Peñalosa, 2010). In ICT-mediated education processes, students can choose the didactic materials that are most interesting to them and generate their own Personal Learning Environments.

Socialization and interaction: Man is a social being and requires others to relate, to work in a community, to socialize, to generate spaces where collaboration among the members of a group is strengthened, as well as peer education. In this sense, the importance of the context acquires a fundamental relevance since it allows the transition from a zone of actual development to an area of proximal development (Vygotsky, 1996). In a learning environment mediated by ICTs, the processes of interaction, communication, and dynamism with the presentation of multimedia resources are favored (Rodríguez, Iglesias & Juanes, 2018; Peñalosa, 2010), the conformation of networks (Perazzo, 2000), a horizontal collaboration between teachers and students (Díaz-Barriga, 2013).

Activity: Activity is a propositional, contextual, contingent phenomenon (Leontiev, 1983) that the learner carries out; it is the functional relationship of the subject with the object where the activity is concretized through actions, operations, tasks, and motives. In this sense, education based on the transmission of knowledge is rejected; the realization of a cognitive effort beyond manual or psychomotor activity is sought. The protagonism of the subject in Virtual Learning Environments increases (Gros, 2011) and constitutes an indispensable element from which teaching is organized, and student learning acquires meaning and significance through active participation in forums (asynchronous communication), videoconferences (synchronous communication), as well as collaborative activities such as Wikis.

Autonomy and independence: The ability allows students to regulate their learning and become aware of their own cognitive and socio-affective. It constitutes the awareness in which the individual performs cognitive and metacognitive processes, i.e., they reflect on their thinking, which allows them to make the best decisions (Crispín, Caudillo, Doria & Esquivel, 2011). As a student progresses through the educational levels, they need to acquire advanced degrees of autonomy and take responsibility for their learning, which with the online, virtual, or distance learning modality, develops more rapidly since it requires organizing their time, achieving the established goals, as well as carrying out a series of activities independently.

Intuition: The resources of real or printed, audiovisual, and computerized character are of practical help for the teaching-learning process since they potentiate the students' learning, mainly used in the levels of Basic Education. However, it is also necessary to consider them in Middle and Higher Education. With the use of different technological tools, it is possible to use diverse materials that allow the recovery of text, images, and sound, but also the use of interactive materials where an intuitive design is required so that they can be easily manipulated and fulfill the objective for which they were created.

Creativity: A world in constant evolution generates problems that demand solutions, and advances in science and technology demand a continuous response to needs. Learning characterized by innovation is increasingly necessary for the society of the 21st century, and the educational process requires preparing students to face different challenges and increase the number of creative solutions. It is essential to develop innovative minds, generate contributions in the various fields of science, feed curiosity, and produce different answers. The use of technological tools favors creativity processes in students by presenting a topic in different ways, using other didactic resources, and sharing different materials with the learning community.

Gamification: The game is an educational factor of enormous importance frequently used in Basic Education levels, and in Higher Education, it is worked with a low percentage. There is a vital link between the game and the development of different skills such as creativity, collaboration, search, analysis, and evaluation of information, in addition to the fact that it increases interest in particular topics and a system of rules, norms, and achievement of objectives is worked on, in addition to the fact that learning becomes more attractive. The subject has an active role during the process. Gamification has made it possible to incorporate game dynamics in the teaching-learning process with the aim of students acquiring knowledge in addition to improving their skills and competencies (Martínez, Santos-Martínez, & Puche, 2018).

Motivation: The analysis of student motivation in the teaching-learning process is fundamental since it is mainly linked to the impact on learning. Though, several factors significantly influence it, such as the type of learning, the characteristics of the students, the discipline being worked, the interest in education, the relationship between students and teachers, the linking of new learning with previous knowledge, the application of knowledge to specific contexts or problem-solving (Díaz-Barriga, 2013). The use of ICT tends to increase the motivation processes in students. However, the mediation carried out is fundamental since, in the beginning, it may be a novelty for the student to handle a specific technological resource, and then the interest decreases.

After having reviewed the incorporation of ICT in educational environments, as well as the importance of recovering the didactic aspects for its implementation, the objective of this research is to identify the perception of Higher Education students mediated by technology regarding the use of didactic principles in the development of their teaching-learning process.

3. Materials and Methods

The research was conducted using a quantitative methodology, which is characterized by the measurement and descriptive statistical analysis of the results (Naupas, Mejía, Novoa & Villagómez, 2014; Coe et al. 2021), the type of study is cross-sectional descriptive being its purpose of describing the qualities of a group of people at a single time (Salinas & Cárdenas, 2009), through a non-experimental design.

The technique used was the survey, and the instrument was the questionnaire "*Didactic Principles in ICT-Mediated Higher Education*" (Table 1), for its design was considered as a basis for the objective established for the study as well as the ICT-mediated didactic principles proposed by García-Aretio (2016), which is made up of 32 items with a Likert-type scale with five response options: Always, Almost always, Sometimes, Rarely and Never; conformed by eight dimensions: (a) *Individualization* (1-4); (b) *Socialization and interaction* (5-8); (c) *Activity* (9-12); (d) *Autonomy and independence* (13-16); (f) *Intuition* (17-20); (g) *Creativity* (21-24); (h) *Gamification* (25-28); and (i) *Motivation* (29-32).

Dimension	Item
Individualization	1.- I organize my time according to my needs. 2.- I study at my own pace. 3.- I take responsibility for my formative process. 4.- I select the resources that suit my learning style.
Socialization and Interaction	5.- I participate in collaborative activities with my group mates. 6.- I synchronously communicate with my peers. 7.- I communicate with my colleagues asynchronously. 8.- I carry out co-evaluation processes.
Activity	9.- I link theory with practice. 10.- I apply what I review in the different subjects in my context. 11.- Development of activities that favor reflection. 12.- Development of activities oriented to analysis.
Autonomy and independence	13.- Increase autonomous learning. 14.- I identify progress in my learning. 15.- I generate self-evaluation processes.

	16.- I make decisions aimed at improving my learning.
Intuition	17.- I intuitively manage the platform. 18.- I identify the different spaces that make up the platform. 19.- I use a variety of resources on the platform. 20.- I increase my learning by reviewing the resources on the platform.
Creativity	21.- I develop creativity when performing my activities and tasks. 22.- I apply the acquired knowledge innovatively. 23.- I solve problems in my context based on what I have seen in the subjects. 24.- I increase my productivity through online study.
Gamification	25.- I consider the game as an educational factor. 26.- I learn through play. 27.- I achieve different objectives through the use of the game. 28.- I use playful software for my learning.
Motivation	29.- It motivates me to carry out my studies virtually. 30.- Making progress in my activities increases my motivation to study. 31.- Reading the feedback given by the teacher increases my motivation. 32.- Participating with my peers increases my motivation.

Table 1. Dimensions and items of Didactic Principles in ICT-mediated Higher Education.
Source: Own elaboration

To validate the instrument, the evaluation of 15 expert judges with recognized experience in the object of study was used, where they were asked to evaluate the questionnaire both in content and form through the reliability analysis of Aiken's V (Aiken, 1985) using dichotomous values of 0 and 1 to determine clarity, coherence, and relevance, obtaining results of .96. A pilot test of the questionnaire was applied to 15 students with similar characteristics where the relevance and pertinence of the items were confirmed. The instrument presents a Cronbach's Alpha of 0.937.

The application was carried out digitally through the Google Drive questionnaire in November 2021 utilizing a non-probabilistic sampling where the study's objective was specified, and the data handling was confidential. A total of 281 graduate students who study in Virtual mode participated, of which 68 were men (24.2%) and 213 women (75.8%), where the average age was 41.

4. Results and Discussion

The results show that the students correctly and successfully fulfilled the didactic principles in the virtual graduate course. This is demonstrated by obtaining higher values than the accepted theoretical average and confirmed by the different statistical tests performed.

Thus, the Kolmogorov normality analysis was carried out to check that a variable is distributed symmetrically or bell-shaped (Lilliefors, 1967); in this case, the data are not homogeneous. That is why it was considered to apply the Wilcoxon test for non-parametric samples (Pedrosa et al., 2015; Flores & Flores, 2021).

From the results, it is observed that all the items are above the theoretical mean, that is, higher than 3, where the principle that obtains the highest score is the item "I take responsibility for my training process" with 4.8, which refers to the importance of generating greater autonomy when studying in the online modality. The lowest values are in the synchronous and asynchronous communication modalities. Table 2 presents the differences in didactic principles in virtual graduate students concerning a theoretical mean, in this case, 3.

Didactic Principles	Media	V	p-Value	Standard Deviation
I organize my time	4.441	33948.5	< 0.001	0.674
Study at my own pace	4.598	36540	< 0.001	0.584
I take responsibility for my training process	4.808	38757.5	< 0.001	0.446
I select resources that suit my learning style.	4.58	36985.5	< 0.001	0.611
I participate in collaborative activities	4.146	27760.5	< 0.001	0.966
Synchronous communication	3.537	17981	< 0.001	1.183
Asynchronous communication	3.573	19011	< 0.001	1.144
Co-evaluation	3.676	20154.5	< 0.001	1.136
linking theory and practice	4.566	35998.5	< 0.001	0.601
Application in context	4.591	34940	< 0.001	0.621
Reflection activities	4.516	35245	< 0.001	0.604
Analysis activities	4.495	34401.5	< 0.001	0.639
Autonomous learning	4.673	36315	< 0.001	0.554
Identification of learning progress	4.651	36244	< 0.001	0.597
Self-evaluation	4.391	31744.5	< 0.001	0.753
Decisions to improve learning	4.651	36781	< 0.001	0.585
Intuitive operation of the platform	4.352	30563.5	< 0.001	0.841
I identify the different spaces that make up the platform.	4.534	34624	< 0.001	0.649

I use a variety of resources on the platform	4.37	31851	< 0.001	0.736
I increase my learning by reviewing the resources on the platform.	4.566	35909.5	< 0.001	0.635
I develop creativity when performing my activities and tasks	4.473	34167.5	< 0.001	0.687
I apply the acquired knowledge in an innovative way	4.441	32640	< 0.001	0.658
I solve problems in my context based on what I have seen in my subjects.	4.466	32799	< 0.001	0.686
Increasing my productivity through online study	4.53	34579.5	< 0.001	0.665
I consider the game as an educational factor	4.53	33419	< 0.001	0.702
I learn through play	4.278	28084	< 0.001	0.833
I achieve different objectives through the use of the game.	4.253	27739.5	< 0.001	0.856
I use didactic software for my learning	3.94	22113.5	< 0.001	0.978
It motivates me to study virtually.	4.516	32687	< 0.001	0.702
Advancing in my activities increases my motivation to study.	4.73	37371.5	< 0.001	0.526
Reading the feedback given by the teacher increases my motivation.	4.694	37142.5	< 0.001	0.614
Participating with my peers increases my motivation.	4.377	31739	< 0.001	0.87

Table 2. Differences in didactic principles in virtual graduate students for an accepted theoretical mean of 3.0. Source: Own elaboration

The results also indicate that the mediation processes that the students perceive on the part of the teachers are appropriate. These results align with other research in which mediation has also proved to be very useful for the positive development of the teaching-learning processes in a virtual context. A study in Mexico agrees on the importance of techno-pedagogical mediation in higher education (Lara Villanueva, 2019). As happens in the Latin American cultural sphere (Martínez et al., 2018; Aguirre et al., 2020), in which we have entered our study.

On an international level, some studies have also highlighted the importance of technology mediation and the need for institutions to provide targeted support to teacher educators across disciplines to adopt consistent technology frameworks for their programs (Nelson, Voithofer & Cheng, 2019).

In the context of the COVID-19 pandemic, which has boosted the use of virtual contexts in higher education, technological mediation has become even more necessary, as demonstrated in a study by Acosta Álvarez, Ortega

González & Díaz Cruz (2020). In this case, it was a face-to-face mediation for the development of virtual processes within a *b-learning* context that has been so frequent in times of pandemic.

Precisely some of the limitations of our work focus on this area. It has been carried out in a completely virtual postgraduate course, but comparing it with a postgraduate course with a mixed methodology (face-to-face and virtual) would be interesting. It is appropriate to analyze whether technological mediation in the face-to-face setting, when ICTs are only used as a support, is as necessary as in a complete e-learning scenario. Some studies suggest that focusing solely on technology-enhanced learning can be misleading and that different emotional, cognitive, and behavioral approaches are needed to assess the true impact of engagement in the pedagogical use of these tools (Dunn & Kennedy, 2019). In addition, research conducted internationally in this context presents studies of a very different nature, such as adoption, critique, social media, podcasting, and blended learning (Shen & Ho, 2020), which make it challenging to establish the representativeness and scope of the findings.

5. Conclusions

In our case study, carried out in a specific virtual program of Higher Education in Mexico, the established objectives have been achieved, and the evident result is a positive perception on the part of the subjects of study towards the use of ICT from the application of didactic principles in their teaching-learning process. The satisfactory results confirm the positive link between ICT and learning.

It is also interesting to observe the access that the study subjects have to ICTs from mobile devices, mainly the use of cell phones and Internet access in their homes, since most of them stated that they have a connection from their homes, which does not require them to travel to other spaces to carry out their activities and tasks. This is fundamental in extreme scenarios, as in the case of the COVID-19 pandemic, which allows the development of teaching-learning processes even in confinement.

In our case, focusing on the adult population and in the context of lifelong education and a professional environment, it can be affirmed that ICT has been incorporated both instrumentally and didactically in the didactic processes in Higher Education, which has allowed people to have the possibility of organizing their time for study, work, and family, and to achieve the objectives of continuing their preparation, being updated and having the opportunity of promotion in their work.

It is pertinent to point out that the mediation processes perceived by the students on the part of the teachers are adequate since the results obtained reflect a high degree of satisfaction in terms of respect for their learning

process, pace, and style, the development of activities to work on higher order processes -such as analysis and synthesis- and to strengthen autonomy and independence. As several of the activities are carried out asynchronously and are required to comply with established times, they have perceived the organization of the platform intuitively. In addition, they have developed creativity and have felt motivated to continue with their studies.

As for interaction and collaboration spaces, it is essential to continue strengthening them since most of the activities carried out by students are individual, a smaller percentage is collaborative, and it is also enriching to consider co-evaluation processes that allow strengthening the formative evaluation in this teaching-learning modality.

For future studies, it will be relevant to apply the same questionnaire to Higher Education students who use ICTs as a support in their teaching-learning process in a *b-learning* context to assess similarities and differences found between those who use ICTs as a learning modality and those who use them as a complement to their learning. In this way, it could be identified whether their use is only instrumental or they have already moved on to a didactic and pedagogical use of ICTs.

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