ORIGINAL

Personal learning environments for distance education students at the Autonomous University of Tamaulipas

Entornos personales de aprendizaje en los estudiantes de educación a distancia de la universidad autónoma de Tamaulipas

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ABSTRACT

The growing demand for flexible education has driven research into Personal Learning Environments (PLEs) in distance learning, highlighting their ability to personalize instruction and promote autonomous learning. A descriptive study was conducted with 158 online students from the Autonomous University of Tamaulipas (UAT), analyzing their PLE usage through surveys. Results revealed a preference for digital tools (websites, videos, and social networks) and reliance on instructor-recommended resources. Key influencing factors included perceived usefulness, accessibility, and collaborative tools. Despite challenges in instructor communication, the study underscores PLEs' potential to enhance online education and recommends greater integration of interactive multimedia resources.

Keywords: Personal Learning Environments; ICT-Based Learning; Distance Education.

RESUMEN

La creciente demanda de educación flexible ha impulsado la investigación Entornos Personales de Aprendizaje (PLE) en la modalidad a distancia, destacando su capacidad para personalizar la enseñanza y promover el aprendizaje autónomo. Se realizó un estudio descriptivo con 158 estudiantes en línea de la Universidad Autónoma de Tamaulipas (UAT), analizando su uso de PLE mediante encuestas. Los resultados mostraron una preferencia por herramientas digitales (páginas web, videos y redes sociales) y una dependencia de recursos recomendados por docentes. Los factores clave que influyen en su experiencia incluyen utilidad percibida, accesibilidad y herramientas colaborativas. A pesar de los retos en comunicación con instructores, el estudio resalta el potencial de los PLE para mejorar la educación en línea y sugiere mayor integración de recursos interactivos y multimedia.

Palabras clave: Entornos Personales de Aprendizaje; Aprendizaje con TIC; Educación a Distancia.

INTRODUCTION

In digital education, Personal Learning Environments (PLE) represent an essential paradigm for knowledge construction, as each student organizes and manages their learning process through particular technological configurations. However, in many higher education institutions, especially those using traditional virtual

platforms, learning management systems are still implemented in a standardized way without considering the individual digital ecologies of students. Similarly, teachers design activities and teach resources under homogeneous schemes, prioritizing institutional uniformity over the techno-pedagogical personalization that PLEs allow. Distance Education, where the use of learning platforms does not always consider the differences in students' study environments and styles. Given that each student faces particular conditions in their learning process, it is essential to research to understand these environments better and offer strategies that benefit both students and teachers.

The present research aims to analyze the personal learning environments (PLE) of distance education students at the Universidad Autónoma de Tamaulipas, specifically in the programs of the Bachelor's Degree in Graphic Design and Digital Animation, the Bachelor's Degree in Education and Learning Technologies, and the Bachelor's Degree in Renewable Energy Engineering. Based on this premise, the following research question is posed: What are the personal learning environments of distance education students at this university? In addition, we seek to identify the advantages and disadvantages students find in using these environments and the digital tools they prefer to facilitate interaction between teachers and students.

According to Torres-Gordillo and Herrero-Vázquez (2016), criticism of LMS platforms has grown over the last ten years due to their teacher-centered model, which imposes a homogeneous system and limits the creativity of students and teachers interested in new ways of teaching. In contrast, a model based on personal learning environments (PLE) is proposed, in which students have control over their educational process and can reuse and remix content according to their interests and needs. Thus, PLEs emerge as a solution to the rigidity and homogeneity of LMSs, as they allow for greater interaction and flexibility in learning. However, it is necessary to identify the benefits and disadvantages of these environments, given that LMSs tend to favor more structured learning styles, excluding those that require more interactive resources. In addition, there is a lack of sufficient information on distance learners' learning styles and environments, as most studies have focused on face-to-face learners. The main objective of this research is to determine the characteristics, styles, and learning environments of distance learners, which will benefit educational institutions, academics, managers, students, and decision-makers.

Fundamental Analysis
Autonomous University of Tamaulipas (UAT)

The Autonomous University of Tamaulipas (UAT) was established in 1956 as a response to the state's cultural and economic growth, with the purpose of consolidating higher education in the region. Its creation was formalised in Decrees 156 and 157, which granted it autonomy, legal personality, and its own patrimony. In 1957, its constitution was reformed to guarantee its independence, and in 1972, by Decree 33, it was granted the power to issue its own Organic Statute.

Located in the state of Tamaulipas, with its rector's office in Ciudad, Victoria, the UAT has a decentralized model, with multiple academic units distributed throughout the state. It is governed by principles of equity, academic excellence, and innovation, training highly qualified professionals committed to society. Its educational offer includes bachelor's, master's, and doctoral degrees in various areas of knowledge, standing out nationally for the quality of its accredited programs and its focus on internationalization.

Academic Organization and Distribution

The UAT is made up of Academic Units, Faculties and Schools, distributed in three regions of the state:
- Northern Zone: nuevo Laredo, Reynosa, Río Bravo, Matamoros and Valle Hermoso.
- Central Zone: Ciudad Victoria and Mante.
- Southern Zone: tampico and Madero.

Each of these zones is home to institutions offering undergraduate and postgraduate programmes in various disciplines, providing training opportunities for students from all over the state.

UAT Distance Learning Degrees
Bachelor's Degree in Graphic Design and Digital Animation

Taught at the Faculty of Architecture, Design, and Urbanism, this degree aims to train professionals to design innovative solutions in visual communication and digital animation. It focuses on creativity, technology, and developing graphic strategies for digital, advertising, and audiovisual media. Graduates acquire skills to develop visual projects in local and international environments, with a strong ethical and social commitment.

Bachelor's Degree in Education and Learning Technologies

Offered at the Valle Hermoso Multidisciplinary Academic Unit, this degree is taught online and is aimed at training specialists in education and educational technology. It seeks to integrate digital tools into the teaching-

learning process, developing innovative proposals to improve education at different levels and modalities. Graduates will be able to work in public and private institutions and in educational research projects.

Renewable Energy Engineering

Taught at the Reynosa-Rodhe Multidisciplinary Academic Unit, this engineering degree responds to the growing global need for sustainable energy sources. It trains specialists in generating, using, and managing renewable energies such as solar, wind, hydraulic, geothermal, and biomass. Graduates will be able to design and develop sustainable energy projects, contributing to the mitigation of climate change and the development of clean technologies.

Distance Education

The concept of distance education is becoming an umbrella under which many expressions and modalities of teaching and learning come together: distance learning, flexible education, open learning, flexible learning, distributed education, and online learning.

This veritable invasion of new names for a concept that has been universally accepted worldwide since 1980 is provoking rearrangements, disagreements, and particular interpretations among experts in the field (Keegan, 1996).

However, above all these discussions, the concept of Distance Education prevails over each new name that appears. Over time, it strengthens and progressively refines its differentiating notes and features to unify its definition. Distance education has undergone a dizzying development in recent times. Current educational problems require increasingly specific solutions, while the development of technology and its multiple educational applications are renewing and increasing its possibilities. In the 1970s, the world witnessed the most impressive phenomenon of the growth of Distance Education and one of the most notorious revolutions in higher education: the creation of the Open University in the United Kingdom in 1969 and the subsequent emergence of similar institutions almost everywhere. This model, hegemonic at the time, did not develop in the same way in South American countries. Argentina, Bolivia, Brazil, Chile, Paraguay, Ecuador, Uruguay and Peru. They did not join this global trend or fulfill the prediction (SEP, 2011).

The explanation for this phenomenon, as Mena (2004) mentions, is painful and straightforward for these countries; when these models were being strongly developed in the world, the Southern Cone was under military regimes that did not prioritize education at the time; all the more reason not to encourage this type of institutions whose declared objective was to democratize access to higher education. Clear evidence of this in Argentina is the closure of the National University of Lujan, which the military government decreed. This was to be the Argentine Open University. Distance education has been a fundamental tool to broaden access to knowledge and to allow learning without the restrictions of face-to-face attendance. Throughout history, it has evolved significantly thanks to technological advances, adapting to the needs of each era and revolutionizing how people acquire knowledge.

The antecedents of distance education date back to the 18th century, when postal mail became the primary medium for teaching outside the classroom. In 1728, Caleb Phillips advertised a shorthand correspondence course in a Boston newspaper, which was considered one of the first formal attempts at distance education. In the mid-19th century, the University of London pioneered distance study programs, providing access to higher education for people who could not physically attend classrooms.

With the advent of mass media in the 20th century, distance education made significant progress. In the 1920s and 1930s, several universities began to use radio to teach classes, allowing students from different regions to access educational content. In the 1950s, television became a key resource for distance education, with specific programs designed to complement traditional teaching. Institutions such as the Open University in the UK adopted this model to deliver courses effectively.

The development of information technology and the advent of the Internet at the end of the 20th century radically transformed distance education. The development of online learning platforms, such as Moodle and Blackboard, facilitated interaction between teachers and students through forums, video conferencing, and digital materials. Prestigious universities began to offer academic programs online, allowing students worldwide to access quality education regardless of their geographic location.

Distance Education in Mexico

Nowadays, distance education is a consolidated modality in constant innovation. Technologies such as artificial intelligence, virtual reality, and automated learning have improved the educational experience, providing more interactive and personalized tools. The COVID-19 pandemic in 2020 accelerated the adoption of online learning models, highlighting this modality's importance in ensuring continuity of learning in emergencies.

According to Navarrete-Cazales and Manzanilla-Granados (2017), in the 20th century, Mexico stood out as one of the countries most interested in offering distance education. National education policies were oriented

towards using information and communication technologies (ICT) to strengthen education systems. The need to make rural populations literate drove the development of this educational modality.

In 1941, the Primary Broadcasting Radio School for Adults and Pondence courses were offered to students in remote areas. Subsequently, on 30 December 1944, the Federal Teacher Training Institute was founded, providing teacher training through two modalities: the Correspondence School, which allowed teachers to be trained without leaving their place of work, and the Oral School, which offered classes during holidays in centers set up to complement teaching and evaluate the knowledge acquired.

Another significant development was the start of the experimental phase of Telesecundaria, which transmitted classes live using microwave technology and closed-circuit television. Subsequently, in 1971, the Centro para el Estudio de Medios y Procedimientos Avanzados de la Educación (CEMPAE) was created, a decentralized body whose function was to plan, coordinate, and promote out-of-school education, as well as promote educational research and experimentation in the country. In 1973, in collaboration with the Instituto Tecnológico de Monterrey, CEMPAE created the first educational television channel in Latin America, located in Monterrey. In addition, it implemented the first open system aimed at intensive primary education for adults.

In 1972, in the framework of a university reform of the National Autonomous University of Mexico (UNAM), the Open University System (SUA) was created, a flexible and innovative educational option in teaching and evaluation methodologies. This system allowed independent study and eliminated time, location, age, and work restrictions, allowing anyone who met the entry requirements to obtain a university degree. In 1997, UNAM established the Coordination of Open University and Distance Education (CUAED), consolidating its efforts in this educational modality.

On the other hand, in 1974, the National Polytechnic Institute (IPN) launched its Open Learning System (Sistema Abierto de Enseñanza, SAE) at various educational levels, from upper secondary to higher education. Over time, this system expanded, giving rise in 2007 to Polivirtual, a proprietary educational platform offering distance and blended learning programs for high school, undergraduate, postgraduate, and complementary educational services.

Since the 1990s, distance education has experienced exponential growth, which intensified in the first decade of the 21st century. Today, most public universities in the country offer distance education programs. The correspondence mode has fallen into disuse, replaced by virtual platforms that include tools such as e-mail, blogs, forums, and virtual classrooms based on LMS Moodle. In this environment, the teacher-counselor is key in guiding student learning.

The implementation of distance education responds to two main objectives: expanding educational coverage in line with the goals of international organizations and fostering digital inclusion and ICT training for teachers, students, and administrative staff. This educational model continues to evolve and adapt to the changing needs of society and technology.

Personal Learning Environments

The Personal Learning Environment (PLE) originated in 2001 in the UK in an article published by Olivier and Liber, who proposed the need for portable personal learning environments to develop lifelong learning. The concept appeared as such at the end of 2004 and was associated with Web 2.0.

Over the last ten years, the dominant positions of LMS platforms have been questioned due to their teacher-centered model with a homogeneous system that limits both teachers and students who are more interested in experimenting with new ideas. In contrast, a model associated with a personal learning center where content is reused and remixed according to the needs and interests of each student is being considered. PLEs thus address the desire to control one's own teaching and learning environment through an ecosystem of connected educational resources, provided with tools and fuelled by opportunities for collaboration.

For Area and Adell (2009), PLE can be defined as "a set of tools that work together in an open, interoperable way and under the control of the learner rather than the teacher or the institution" (p. 419). For Rodrígues and Lobato (2013), it is a personal learning space directed by personal rules and mediated by technological tools that allow externalizing and relating knowledge with peers connected in the same web space.

In this space, there is multifaceted information meant to be shared, enhanced, and established as a common good and implicitly structured in mental schemas, organized by technologies that improve visual memory through communication, thought, and reflection and offer free, autonomous, and learner-controlled learning. Concretely, we could say that a PLE is a self-defined collection of services, tools, and devices that allows students to form their Personal Learning Network (PLN) or Personal Knowledge Network (PKN), putting in common nodes of tacit knowledge (e.g., People) and nodes of explicit knowledge (e.g., Information) (Gutiérrez-Esteban, P. and Becerra Traver, M.T., 2014, p. 52).

According to Adell and Castañeda (2010), the PLE or Personal Learning Environment would be a new approach to learning that collaborates with the acquisition of digital competencies and recognizes the existence of a personal lifelong learning environment that is constructed and shared by the set of people who form part of

the individual, professional and social environment. This Personal Learning Environment is currently made up of three distinct parts: "1) Tools, mechanisms, and activities for reading; 2) Tools, mechanisms, and activities for doing/reflecting by doing; and 3) Tools, mechanisms, and activities for sharing and reflecting in community or PLN (Personal Learning Network)". (GutiérrezEsteban, P. and Becerra Traver, M.T., 2014, p. 52).

Similarly, Torres-Gordillo and Herrero-Vázquez (2016) state that the PLE collaborates with personal and individualized lifelong learning efforts and learning within more structured educational contexts with organized activities such as universities. The authors identify three elements of the PLE, which, in turn, form basic cognitive processes:

- Reading tools and strategies: for accessing information, such as publishing sites (blogs, wikis), audio repositories or databases (iTunes, podcasts...), video (Youtube, Vimeo...), RSS readers (Bloglines, Google Reader...), portals, etc.
- Reflection tools and strategies: where to write, comment and analyse, with which we can transform information, such as mind mapping applications (CMapTools, Creatively...), audio (Soundation Studio...) and video editing (Youtube Video Editor...), creation of presentations (Prezi...), etc.
- Relationship tools and strategies: social network sharing, where we relate to others from/with whom we learn, such as Facebook, Twitter...(p. 29).
- Área and Sanabria (2014) cited by Torres-Gordillo and Herrero-Vázquez (2016) identify three PLE formats in academic contexts: personalised digital environment generated through the application of a specific technology such as web pages, platforms; a self-constructed digital representation of non-formal learning in the network such as maps and graphics and a digital product in e-portfolio format.

There are two current definitions of PLE. The first comprises authors who inherited the term from the JISC/CETIS Conference meeting and admit that the PLE is a technological environment that emphasizes student action and the flexibility that such an environment provides for the learner. For this group of authors, the PLE is a type of software platform, i.e., a learner-centered system with a particular structure, parts, and functions that allow the management of a range of different tools (Van Harmelen, 2006).

On the other hand, there is another group for whom a PLE is a pedagogical idea and a practice of people learning through technology. It is conceived as a form of knowing where the internet is used and where a web is generated that each person creates on the network to develop their learning environment (Atwell, 2007) (Downes, 2010).

Online Education Platforms

According to Viñas (2017), in contrast to traditional face-to-face training, other tools, such as the so-called e-learning platforms (LMS), provide other teaching modalities that can be used in the classroom. These modalities can be classified according to their use: B-learning (they support face-to-face teaching); E-learning (totally distance learning through the use of Internet-based technologies); M-learning (learning through the use of mobile technologies); T-learning (transformative learning system in which the use of new technologies is part of the process); W-learning (comprises cooperative distance learning based on collaborative web 2.0 tools).

About the choice of an e-learning platform, specific characteristics such as language, documentation, ease of installation, security, management and creation of learning objects, speed of access, content organization, support, and functionalities must be considered. In addition, there are several variants of platforms, such as open access (e.g., Claroline, Chamilo, Didactalia), commercial (e.g., Blackboard and E-educativa), and cloud-based (Udemy).

Moodle

The first Moodle site was registered in 2001, and Peter Taylor published an interpretive analysis of an internet-based course built using a course tool called Moodle in November of that year. By the end of that year, Moodle could be downloaded via CVS, and basic installation documentation was available.

The site grew rapidly, and in 2004, companies applied to become Moodle partners. Since 2007, Moodle has been a leading and award-winning open-source LMS standard. It reached one million users in 2010 and about 50 Moodle partners. Thus, in November 2012, Moodle 2.0 arrived, and in September, the official Moodle MOOC was launched, which introduced more than 9000 participants to the basic features of Moodle.

A large body of research investigates the outcomes of ICT applications in teaching and learning processes. We will focus on applying digital tools to mathematics learning in this case. The first work reviewed is the study by Arana Palomino (2012), in which the impact of the Moodle tool on learning function limits is investigated. A quasi-experimental design was used for the study, and instruments were applied to measure the impact on attitude, skills, and abilities at the beginning, during, and end of the time stipulated for the research. This research arose in response to the need to improve the quality of mathematics teaching. Two groups of students were compared, one experimental and the other control, and a survey with Likert-type scales was used to assess attitude.

The virtual laboratory, designed by the researcher, included recorded lectures, guided workshops, Geogebra simulation tools, feedback on the workshops and/or practices carried out, teleconferences and question and answer forums, and a space for consulting notes. In the conclusions, the researcher highlighted the improvement in the group's grades participating in the virtual mathematics laboratory.

Another of the research studies reviewed refers to applying the Moodle platform in an educational institution in Colombia (Grisales Pérez, 2013). In this case, the Moodle platform was implemented in basic areas of knowledge such as mathematics, natural sciences, humanities, social sciences, philosophy, and political science. It was applied to eighth, ninth, tenth, and eleventh grades. This initiative arose in response to the need to involve ICT as a tool in the teaching and learning processes. Through the platform, the teacher interacted virtually with the students, which motivated the student›s appropriation of the process of knowledge acquisition. It was found that this methodology has certain benefits, such as saving time for grading and analyzing data; it also allows the use of various techniques for knowledge feedback and collaborates with the generation of ecological awareness by reducing the use of printed material. The application of different Moodle tools allowed teachers to make classes more dynamic, involve students in the educational process, and optimize the resources and time used by teachers in the organization and marking of assignments and exams.

Blackboard

Blackboard is an educational platform that enables interaction between one or more users for pedagogical purposes. It is an evolution of learning and teaching processes and also functions as a complement to traditional education. Most educational platforms are software or electronic hardware. Blackboard Learning System is a simple and intuitive computer platform used by several universities in the United States that contains basic functions to create content and documents for the administration of a course via the Internet (Ferreiro Martínez, V.; Garambullo, A.; Brito Laredo, J., 2013).

According to Villalón, Luna, and García Barrera (2019), Blackboard Collaborate (its previous version was Elluminate Live) is compatible with the three most widely used operating systems and can be integrated with Moodle learning environments. It allows synchronous communication via videoconferencing, instant messaging, voice transmission, and sharing of different types of files. It allows sharing the administrator's desktop and giving control to the learner, which implies a high degree of collaboration and feedback between users. It is also possible to use asynchronous material, as live material can be videotaped. The tool can be used for various uses: live instruction, meetings, asynchronous content development, and tutoring programs.

According to Ferreiro Martínez et al. (2013), this platform's benefits include improving individual and institutional performance, offering interactive, individualised learning experiences, and providing services and experiences that meet learners' expectations.

It was designed for teaching and learning institutions. The technology and resources offered by the platform are used for the development of hybrid educational programs optimized by the Internet. As an educational platform it has the following resources: course administration eliminating the stress of administrative management; instructional tools for the creation of professional and high-quality content; collaboration and communication, including free conversations, chat dissertations, question and answer chats, archives, discussion spaces, whiteboarding, class tours and group web browsing including session recording and storage, calendar and agenda and blackboard messages allowing communication between users without the need for an email account; assessment and evaluation (Ferreiro Martínez, V.; Garambullo, A.; Garambullo, A.).Garambullo, A.; Brito Laredo, J., 2013).

METHOD

The present research aims to identify the personal learning environments of distance learning students at the Autonomous University of Tamaulipas, specifically the students of the following educational programmes:

- Bachelor's Degree in Graphic Design and Digital Animation.
- Bachelor's Degree in Education and Learning Technologies.
- Renewable Energy Engineering.

These are all educational plans that are taught at a distance, specifically in the online modality.

Research design

The research will have a quantitative approach with a descriptive design as it aims to identify and describe learning styles. Three types of data collection instruments are used which refer to learning in PLE environments; personal learning environments and learning styles.

Universe and research sample

For this research, the object of study is the students of the undergraduate educational programs that are entirely taught at a distance at the Autonomous University of Tamaulipas. Three undergraduate degrees,

the Bachelor's Degree in Graphic Design and Digital Animation and the Bachelor's Degree in Education and Technologies for Learning and Engineering in Renewable Energies, were identified, all of which are educational plans taught in the online modality.

301 students enrolled in the Bachelor's Degree in Graphic Design and Digital Animation for the period 2021. Ninety-one students represent the enrolment of the Bachelor in Education and Learning Technologies 2021. One hundred thirty-six students represent the enrolment in Renewable Energy Engineering 2021.

This information was requested from each of the degree course coordinators by e-mail and telephone. In this exercise, the coordinators were asked to enroll the active students, i.e., the students carrying out the activities indicated in each distance learning subject.

Therefore, the total universe of the research is 528 students.

To obtain the margin of error and sample size, the tool https://es.surveymonkey.com/mp/margin-of-error-calculator/ was used to obtain a confidence level of 90 % with a margin of error of 5 %.

This tool yielded a sample calculation of 158 students using this number as a minimum number of surveys for this research.

Description of the Instrument

The personal learning environments instrument (García Martínez and González-Sanmamed, 2017) was used to investigate the types of information searches, motivations, and uses of information by students. The instrument comprises 19 questions, aiming to collect information regarding the virtual tools used, information search, search motives, and uses. The 19 questions found in the questionnaire are multiple-choice questions. The purpose of this instrument is to investigate what the personal learning environments of Distance Education students are like; this instrument is intended to collect information to address the objective, general question, and secondary questions of this research.

In the questionnaires of personal learning environments and evaluation of learning in virtual environments, three questions were added to obtain general data, such as gender, age, and the educational program to which each distance education student belonged.

Instrument application process

The instrument's form was developed using a technological application integrated into Microsoft Office 365 called Microsoft Forms, which facilitated the development of the graphs and analysis of the information.

The process involved contacting each educational program coordinator by email and telephone to request permission to use the questionnaires so that they could be retransmitted to the students of the different academic programs through their coordination.

Once the instruments were ready in Microsoft Forms, the links were generated to share them with the coordinators of the educational programs, who in turn transmitted them to all the students enrolled in the 2021 period; the questionnaires were retransmitted via the University's institutional email.
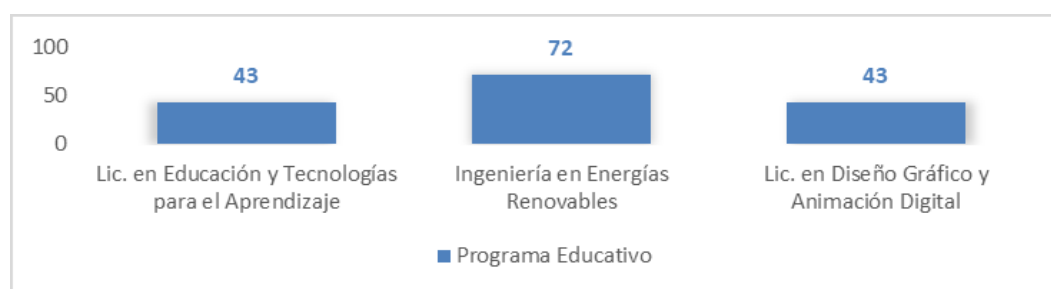
RESULTS

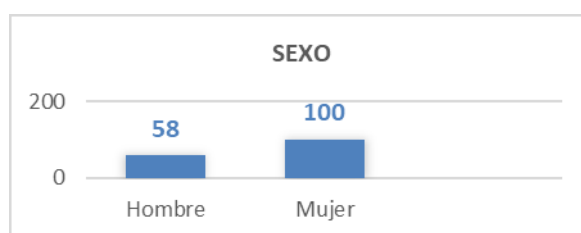**Figure 1.** Educational programme graphic

Figure 2. Gender graph

The survey was applied to the three bachelor's degrees that the UAT offers completely online: the Bachelor's Degree in Graphic Design and Digital Animation with 43 students, which is equivalent to 27,2 % of the sample, and the Bachelor's Degree in Education and Learning Technologies with 43 students, also equivalent to 27,2 %, and the Renewable Energy Engineering with 72 students who participated, and as can be seen in the graph, they were the students who responded the most, representing 45,6 % of the sample collected.

Of the 158 students surveyed, a total of 100 females (63,3 %) participated, leaving 58 males (36,7 %) below the male sample.
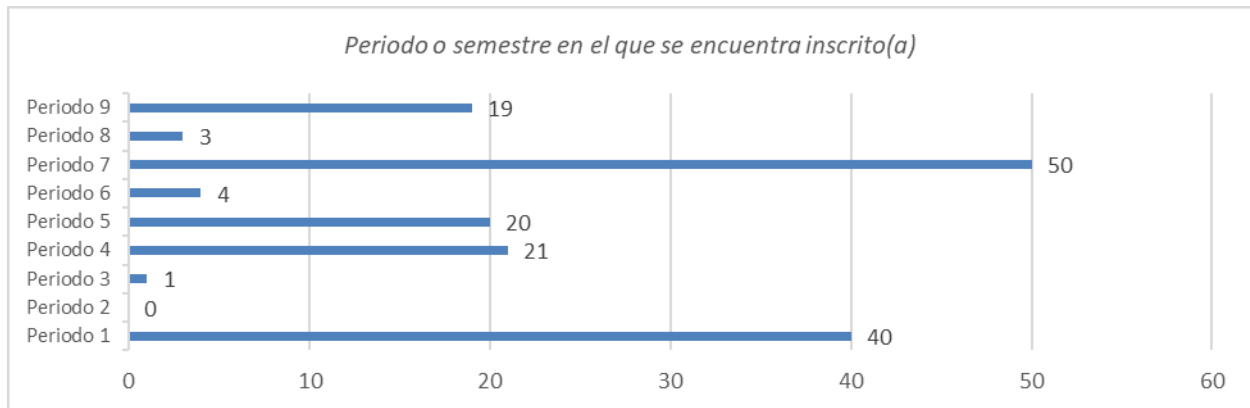

Figure 3. Graph showing the period or semester in which you are enrolled(a)

In this graph, we can see the 158 students who participated; the students who answered this instrument were from different periods, with students from period 7 standing out with 50 students, equivalent to 31,64 % of the sample, and the first period with 40 students which is equivalent to 25,3 % of the sample, within the lowest participation we can see students from period 8 with three students representing 1,89 % and period 3 representing 0,06 % of the sample collected.
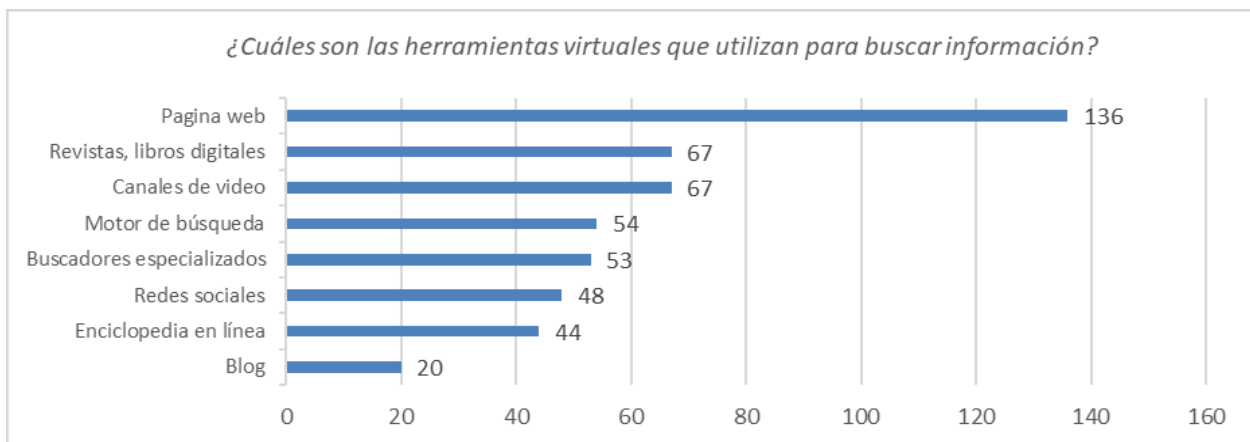

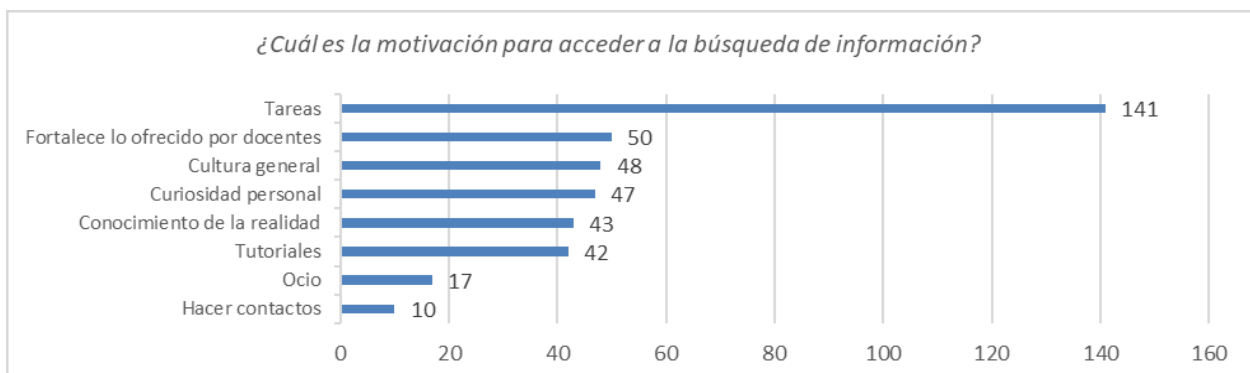**Figure 4.** Graph of What virtual tools do they use to search for information?

Figure 5. Graph of What is the motivation for accessing information search?

The graph shows the results of the question, "What virtual tools do you use to search for information? As can be seen, the virtual tools most used by students are web pages with 136 students, followed by video channels, magazines, books, and digital with 67 students. It can also be seen that a total of 53 students use specialized search engines, 48 students use social networks, and 20 students use blogs as tools to search for information.

The results shown in the graph to the question What is the motivation for accessing information search? Here, we can observe that homework is the primary motivation for accessing the information search. On the other hand, 48 students are motivated by learning general culture and 47 by personal curiosity; we can also observe that 50 students are motivated to strengthen what the teachers offer, 17 do it for leisure, and 10 to make contacts.
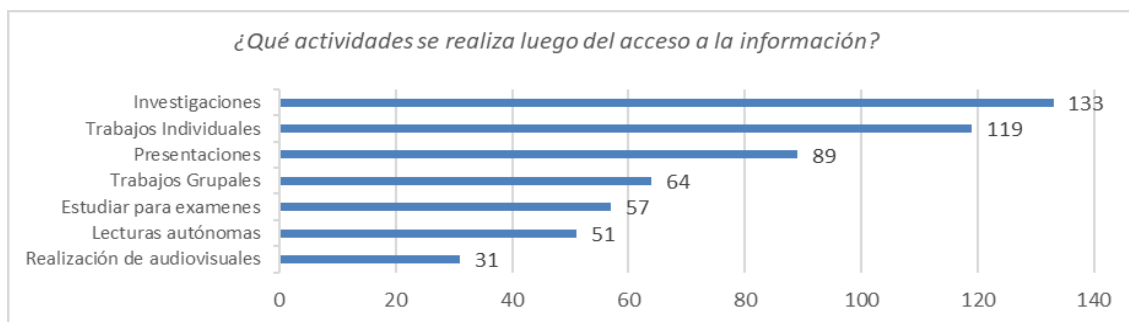
¿Qué actividades se realiza luego del acceso a la información?

Activity	Value
Investigaciones	133
Trabajos Individuales	119
Presentaciones	89
Trabajos Grupales	64
Estudiar para examenes	57
Lecturas autónomas	51
Realización de audiovisuales	31

Figure 6. Graph of What activities are done after accessing information?

The following graph shows the results of the answer to the question, "What activities are carried out after accessing the information? Here, we can observe that once the information is accessed, it is mainly used for research, in which 133 students selected this item, in second place for individual work with 119 students, in third place for making presentations, in fourth place we have group work with 64 students and it is also observed that 51 students use it for independent reading, on the other hand, 55 students use the information to study for their exams and in the graph it is also observed that 31 students make audio-visuals.
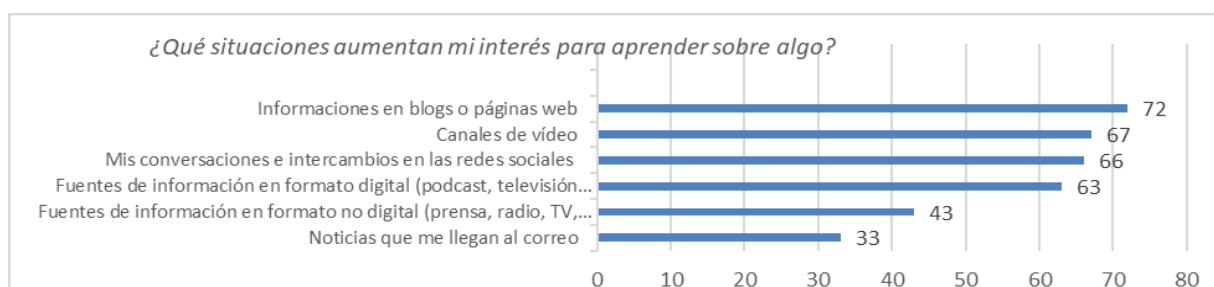
¿Qué situaciones aumentan mi interés para aprender sobre algo?

Situation	Value
Informaciones en blogs o páginas web	72
Canales de vídeo	67
Mis conversaciones e intercambios en las redes sociales	66
Fuentes de información en formato digital (podcast, televisión…	63
Fuentes de información en formato no digital (prensa, radio, TV,…	43
Noticias que me llegan al correo	33

Figure 7. Graph and term cloud for the question What situations increase my interest in learning about something?

Cuando quiero aprender algo nuevo acudo a:

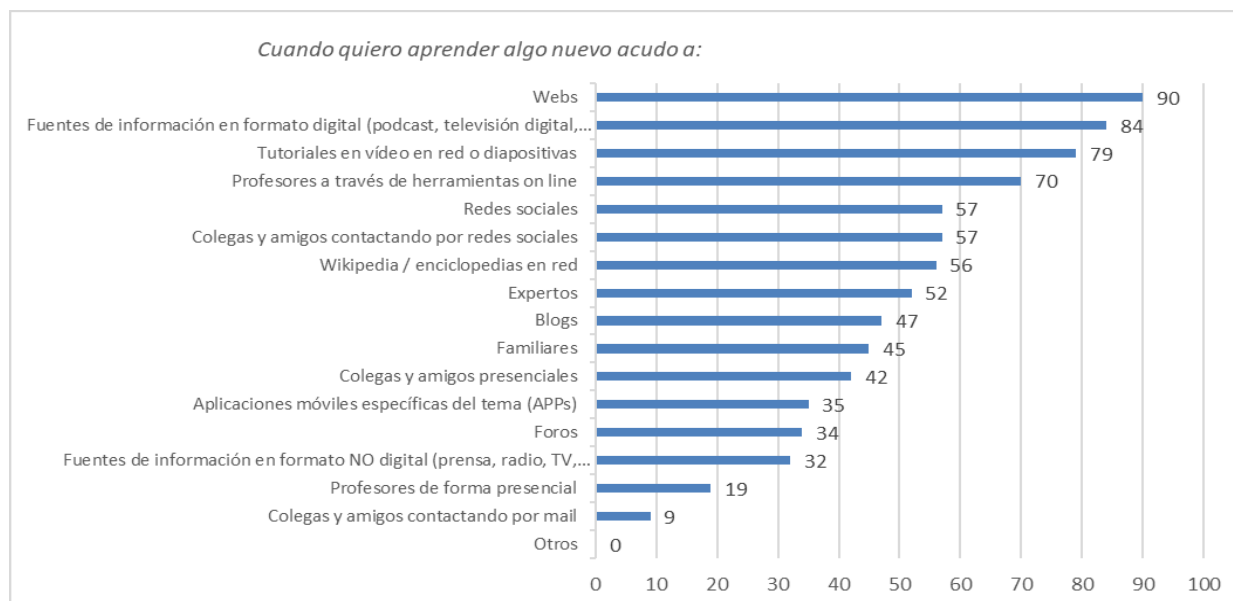| Source	Value
Webs	90
Fuentes de información en formato digital (podcast, televisión digital,…	84
Tutoriales en vídeo en red o diapositivas	79
Profesores a través de herramientas on line	70
Redes sociales	57
Colegas y amigos contactando por redes sociales	57
Wikipedia / enciclopedias en red	56
Expertos	52
Blogs	47
Familiares	45
Colegas y amigos presenciales	42
Aplicaciones móviles específicas del tema (APPs)	35
Foros	34
Fuentes de información en formato NO digital (prensa, radio, TV,…	32
Profesores de forma presencial	19
Colegas y amigos contactando por mail	9
Otros	0

Figure 8. Graph of When I want to learn something new I go to

In the graph that answers the question, "What situations increase my interest in learning about something? It can be seen that there is not much margin of difference between the interests presented to the students, as it can be seen that almost the same number of students selected the same interests, such as video channels with 66 students, information on blogs, web pages with 72 students, conversations and exchanges on social networks with 66 students and digital information sources with 63 students, on the other hand, those that few students selected, but without demeriting them in importance were with 33 students the option of news that arrives in the mail, as well as sources of information in a non-digital format with 43 students.

This graph shows that based on the sample of 158 students for this instrument, 90 students prefer websites when they want to learn something new; in second place are digital information sources such as podcasts, digital television, and newspapers; in third place are video tutorials and slides with 79 students, in fourth place are teachers through online tools with 70 students. Teachers through online tools with 70 students. On the other hand, we can also observe that 52 students turn to experts when they want to learn something new.
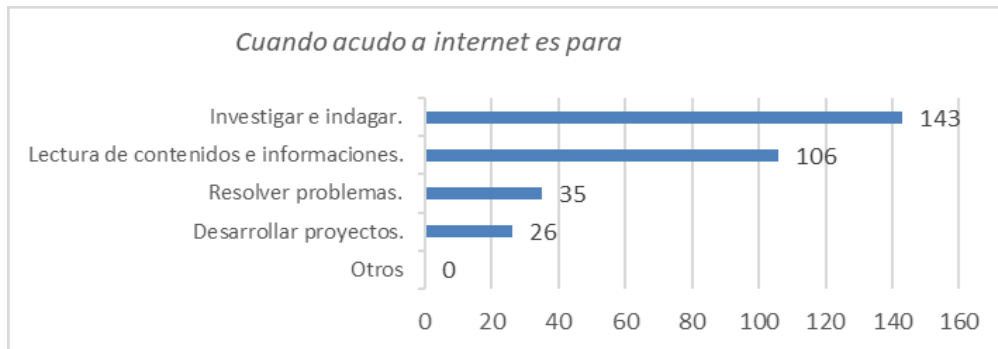

Figure 9. Graph of When I use the Internet it is for

The graph shows another question similar to the previous one. Four items stand out: when a distance learner wants to learn something new, he/she prefers to research and investigate. Secondly, he/she goes to readings of information content with 106 students; 35 students go to solve problems to learn something new, and 26 students develop projects.
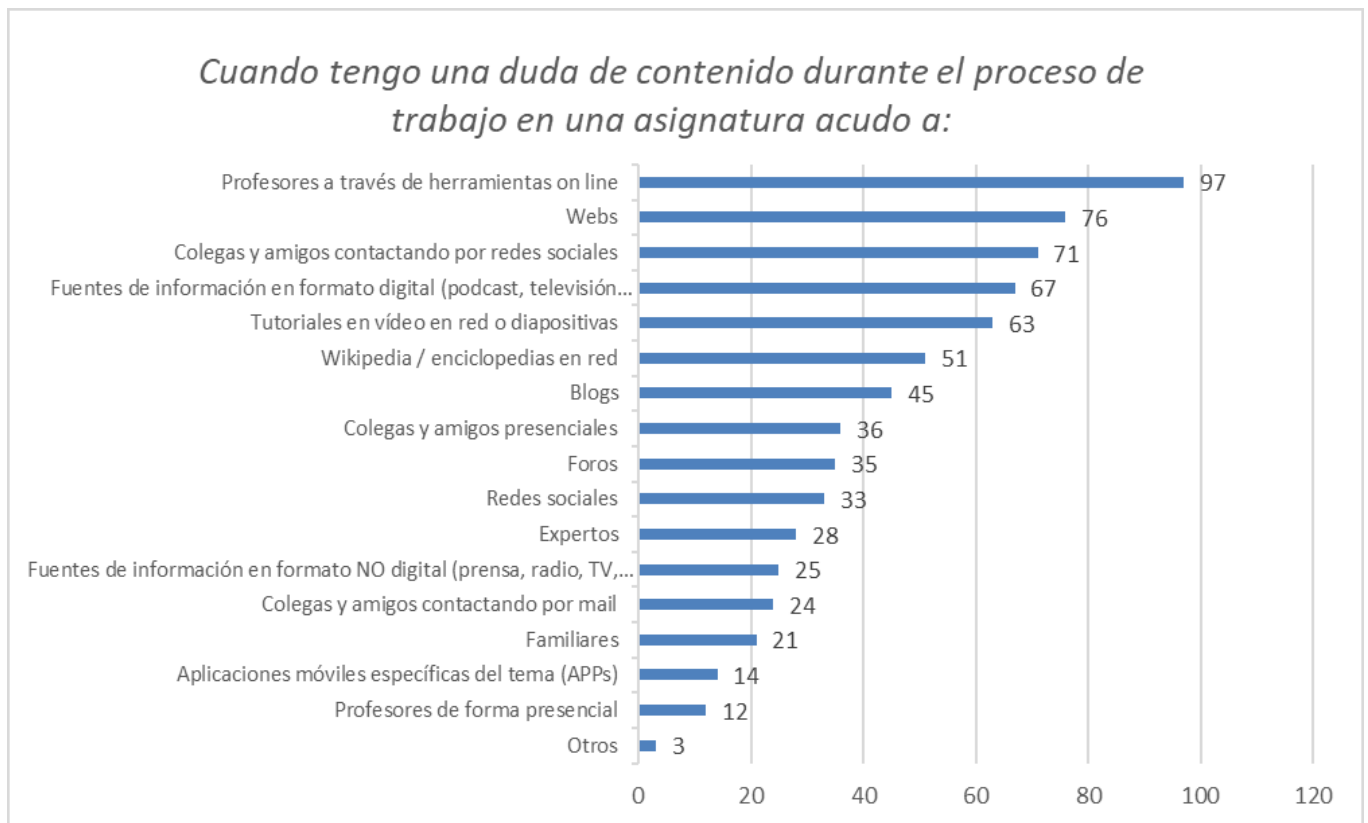

Figure 10. Graph of When I have a doubt about content during the process of working on a subject I go to

This graph shows the results of the question, "When I doubt content during the work process in a subject, do I go to? This question was asked with multiple answers, which is why more students were observed, and their total is greater than the collected sample of 158 students; the answer that stands out is that when students have doubts about the content of their subjects, they contact their teachers through online tools, this answer was preferred by 97 students in second place, it is found that they go to websites, the students who selected this option were 76, In third place, we can observe that when they have doubts, they contact colleagues and friends connected by social networks, in fourth place the sources of information in digital formats such as podcasts, digital television, and press which was selected by 67 students, in fifth place we observe 63 students who prefer to consult video tutorials on the network or slides when they have any doubts in their subjects.

On the other hand, the option of experts only obtained 28 students. Remembering that the students who were applied to this questionnaire were distance learners, it is observed that the lowest selected option was face-to-face teachers.

Cuando tengo un problema técnico acudo a:

Opción	Valor
Expertos	64
Profesores a través de herramientas on line	60
Tutoriales en vídeo en red o diapositivas	52
Webs	50
Familiares	45
Fuentes de información en formato digital (podcast, televisión digital,…)	41
Colegas y amigos contactando por redes sociales	41
Colegas y amigos presenciales	33
Redes sociales	25
Colegas y amigos contactando por mail	23
Blogs	22
Foros	20
Aplicaciones móviles específicas del tema (APPs)	15
Wikipedia / enciclopedias en red	14
Profesores de forma presencial	12
Fuentes de información en formato NO digital (prensa, radio, TV,…)	11
Otros	1

Figure 11. Graph of When I have a technical problem, I go to

This graph shows that students with technical problems turn to experts, obtaining this option, with 64 students in second place. We have teachers through online tools with 60 students in third place; we have video tutorials on the net or slides in fourth place; we have the web with 50 students; in fifth place is the family with 45 students. These are the 5:00 most selected responses, as seen in the graph; on the other hand, the least selected option when students have a technical problem was the information sources in the non-digital format, such as press Radio, Television, or books.
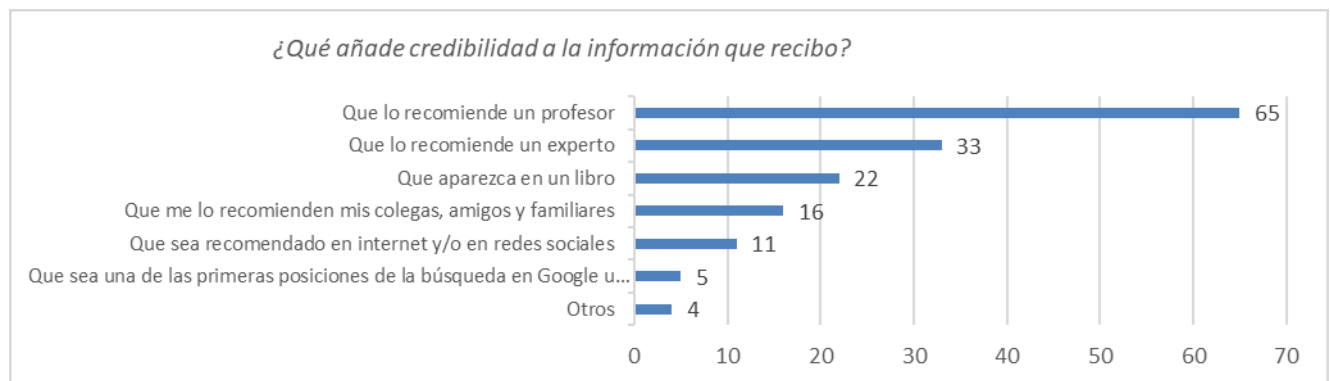

¿Qué añade credibilidad a la información que recibo?

Opción	Valor
Que lo recomiende un profesor	65
Que lo recomiende un experto	33
Que aparezca en un libro	22
Que me lo recomienden mis colegas, amigos y familiares	16
Que sea recomendado en internet y/o en redes sociales	11
Que sea una de las primeras posiciones de la búsqueda en Google u…	5
Otros	4

Figure 12. Graph of What adds credibility to the information I receive?

The graph answers: what adds credibility to the information I receive? Here, we can see that students have high credibility with the information they receive from teachers as the students who selected this option were 65 students, the second most selected answer was to be recommended by an expert with 33 students; in third place, credibility was obtained by the information appearing in a book, in fourth place on the credibility of the information in distance students, is that it is recommended by colleagues, friends or relatives, the two least selected on the credibility of the information received was that it is recommended on the internet or social networks with 11 students and that it appears in the first positions of Google or other internet search engines with five students selected. It is raining.
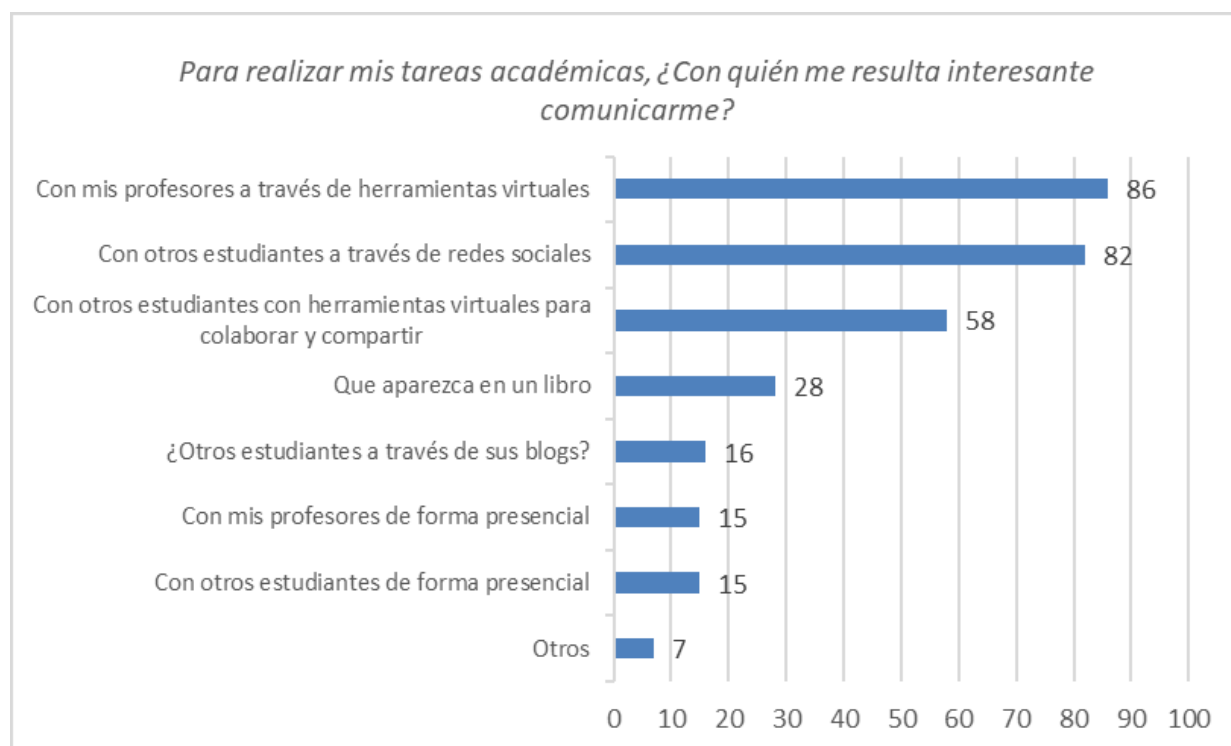
Figure 13. Graph of in order to carry out my academic tasks, who do I find interesting to communicate with?

In the question for my academic tasks, with whom do I find it interesting to communicate? This question is also a question in which multiple answers can be selected, in which students mainly selected the option of what they found most interesting to communicate with teachers through virtual tools 86 students selected this answer Coma in second place, with 82 students finding it interesting to communicate with other students through social networks in third place also highlight students using virtual tools to collaborate and share which was chosen by 58 students, In the graph for this question we can also observe that one of the least selected answers was with 15 students.

In the graph that corresponds to the question asked when I work with information to understand it better, 103 students prefer it to be through videos, 102 students prefer it to be textual, 89 students prefer it to be iconic, i.e., through photographs or images, 60 students prefer multimedia and 36 students prefer it to be audio. So, the two most selected options were textual and video.
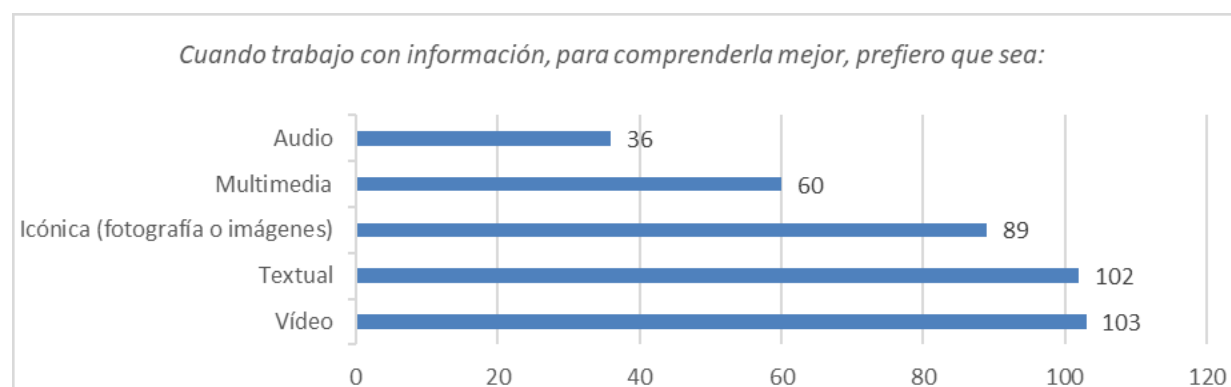

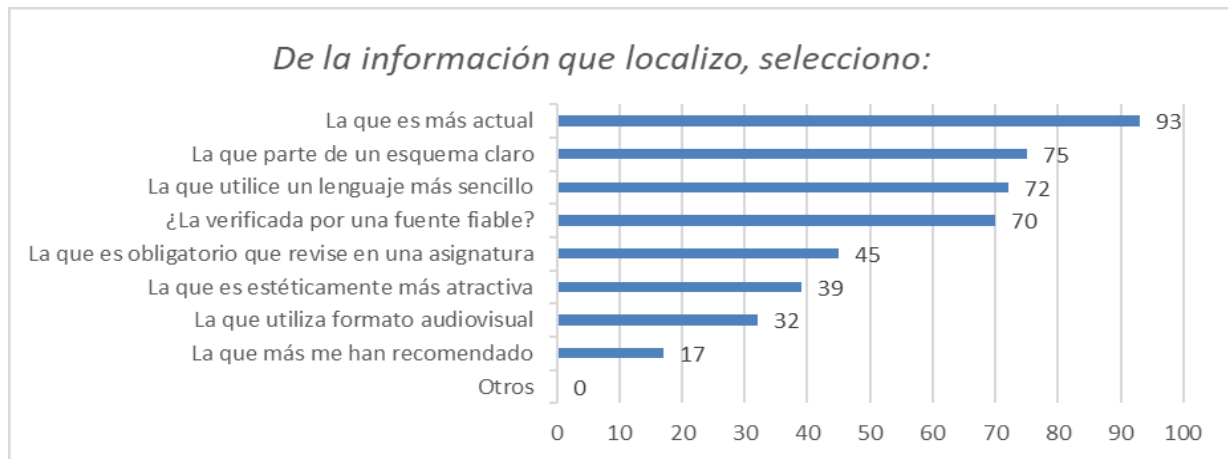**Figure 14.** Graph of When I work with information, I prefer it to be

Figure 15. Graph From the information that I locate, I select

The following graph is also a graph with a question in which different answers can be selected. The question that was asked was, of the information that they locate which is the one that they select, 93 students selected the most current information; in second place, we can group 3 options since they obtained almost the same score, which is the information that starts from a clear scheme, the one that uses a simpler language, and the one that is verified by a reliable source, in a third place we can place the information of a subject. The one with the lowest score is the recommended information for 17 students.
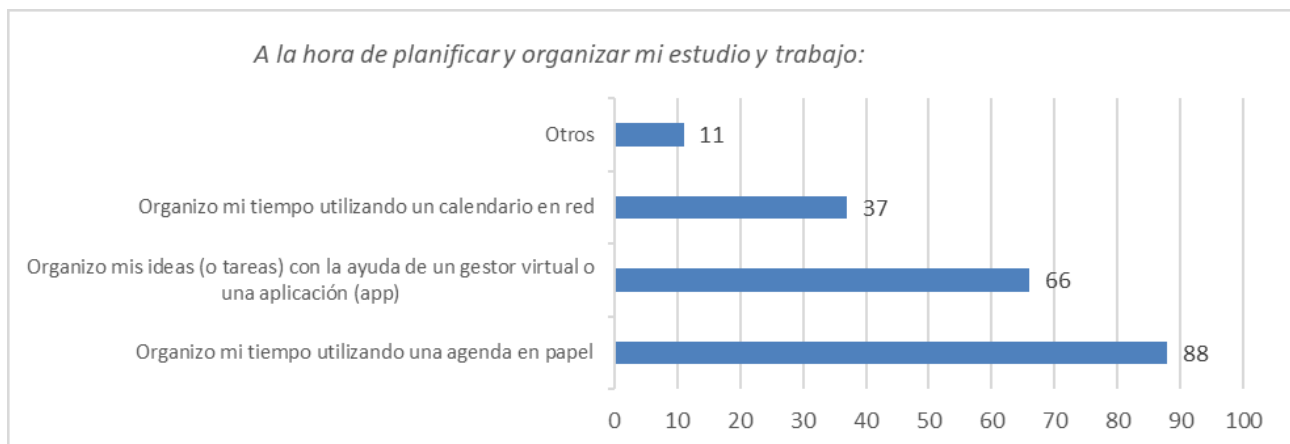

Figure 16. Graph of When planning and organising my study and work

This graph, as we have been pointing out, is also a question where students can choose several answers, in which they answer how they organize and plan their study work. 88 students organize their time using a paper diary; in second place with 66 students are the students who organize their ideas and tasks using a virtual manager or application; in third place, they organize their time using a network calendar.
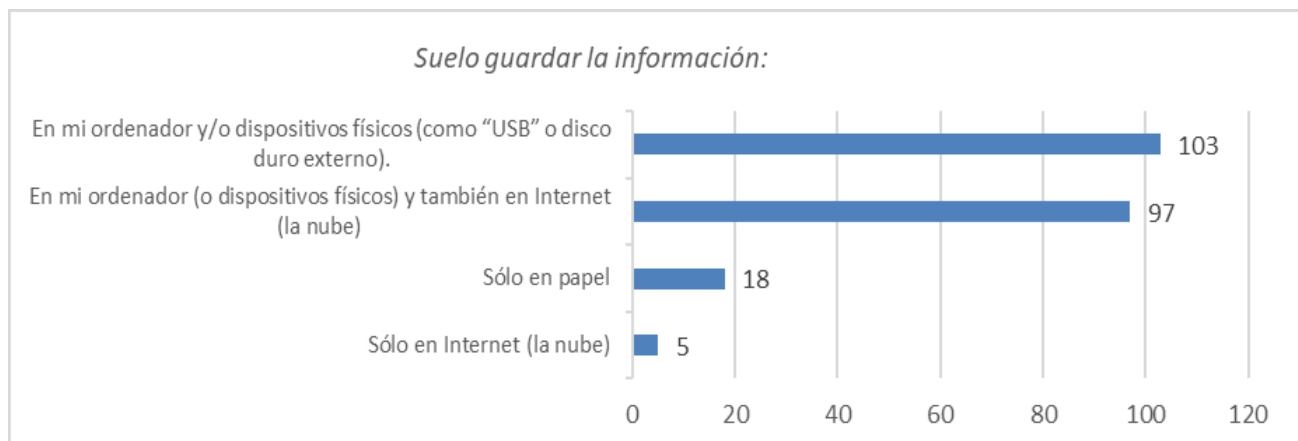

Figure 17. Graph of how information is stored

In the question of ground to save the information, the one that obtained a higher selection by the students is that students save the information on the computer on physical devices such as USB or external hard drives in second place the cloud internet and on physical devices, 18 students chose that only paper and five students store the information in the cloud.
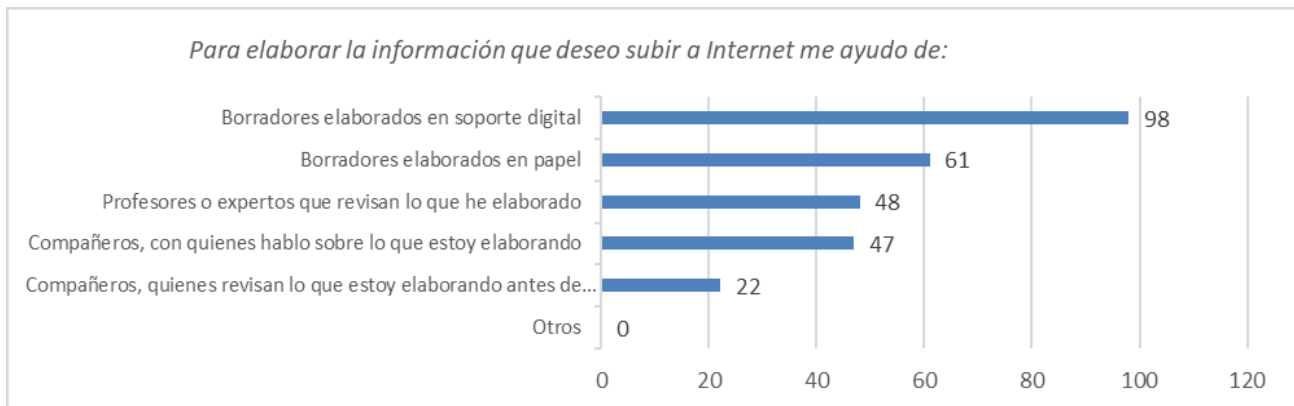

Figure 18. Graph of in order to elaborate the information I want to upload to the Internet I use

This graph represents how students help each other to elaborate information and upload it to the Internet, the most selected being drafts elaborated in digital support, in second place with 61 students, drafts elaborated on paper, in third place, 48 students chose teachers or experts who review what has been elaborated, in fourth place, students are supported by peers with whom they have spoken. The one with the lowest number of students selected as peer reviewers who reviewed what I was working on before I published it.
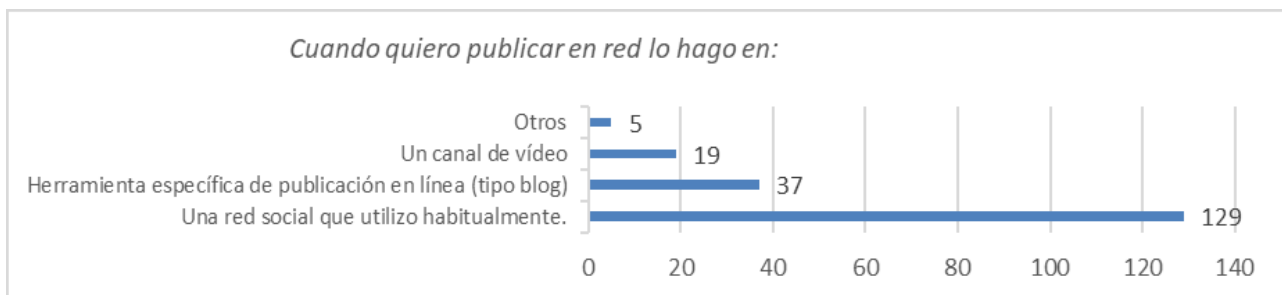

Figure 19. Graph of When I want to publish on the net I do it in

This graph represents the results of where students publish when they want to publish information on the network; it was found that 129 students use a social network that they usually use, in second place specific online publishing tools such as blogs, in third place with 19 students do it through video channels on the network.
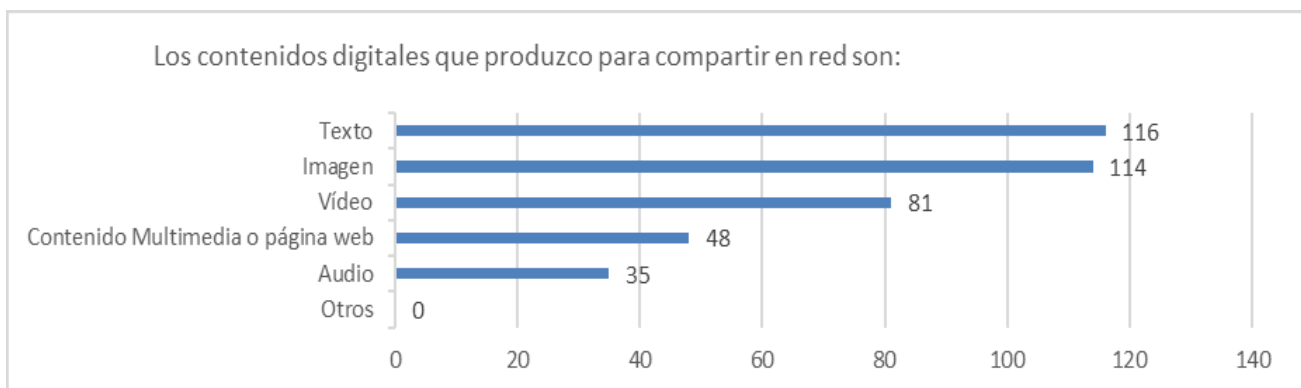

Figure 20. Graph of the digital content that I produce to share on the net are

The following graph represents the results on what type of digital content students produce to share on the network. The graph shows that 116 students use the production of digital texts. Secondly, students produce

digital products such as images, which 114 students selected; thirdly, digital products such as videos 81 students; fourthly, we have multimedia content and web pages, which 48 students selected; and fifthly, we have the production of digital content with audio format with 35 students.
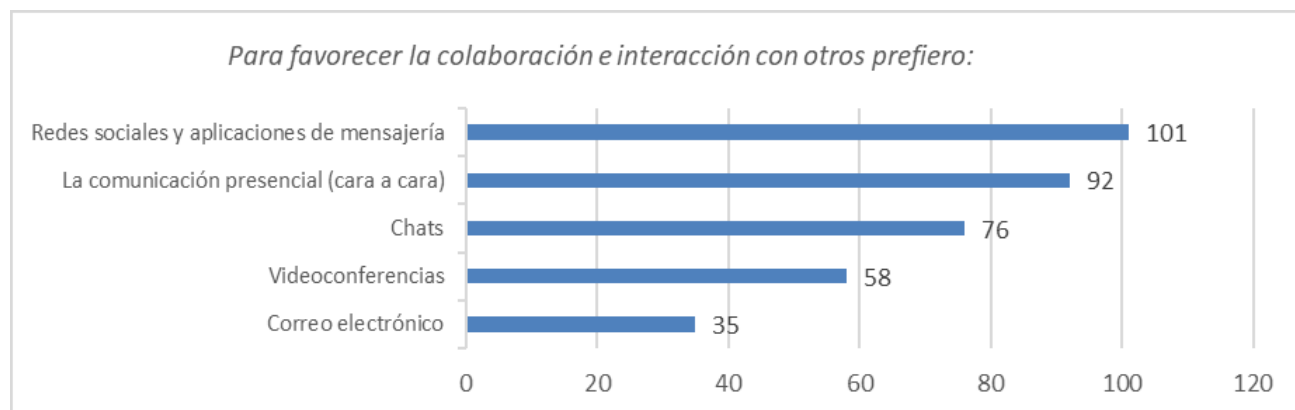

Figure 21. Graph of to favour collaboration and interaction with others I prefer to

This graph shows the results of what students prefer to favor collaboration and interaction with others, highlighting in first place social networks and messaging applications with 101 students, in second place face-to-face communication, in third place they prefer collaboration and interaction through chat with 76 students, 58 students prefer interaction with others through videoconferencing and in last place we have email with 35 students.
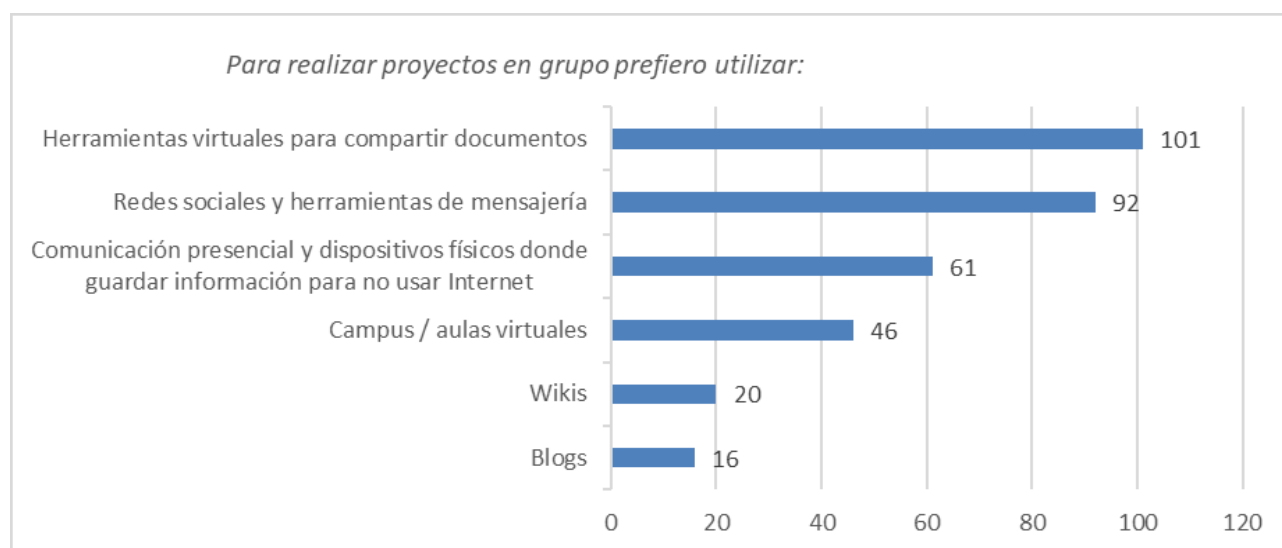

Figure 22. Graph of to carry out group projects I prefer to use

This graph shows the results of the students in terms of what they prefer to use when carrying out group projects, with 101 students in first place with the item virtual tools for sharing documents, in second place with 92 students with social networks and messaging tools, in third place face-to-face communication and physical devices to save information so as not to use the internet with 61 students, in fourth place are virtual campuses and classrooms with 46 students, in fifth and sixth place we have wikis and blogs respectively, wikis with 20 students and blogs with 16 students.

Responding to the research questions:
1. Personal learning environments in distance education students at the UAT
Distance education students at the Autonomous University of Tamaulipas (UAT) shape their Learning Environments (PLE) through a combination of digital tools, knowledge management strategies, and interaction dynamics. The study revealed that these environments are structured along three key dimensions.

First, information access tools include predominantly websites, used by 86 % of respondents, followed by video channels (42 %), digital magazines and books (30 %), and specialized search engines (34 %). A relevant fact is that, although students value autonomy in their learning, they still depend to a large extent on the resources recommended by teachers.

Secondly, reflection strategies focus on transforming the information acquired. Students prefer to internalize content by producing digital texts (73 %), images (72 %), and videos (51 %). This trend reflects a preference for multimedia formats that facilitate understanding and retention of knowledge.

Finally, relationship strategies highlight the use of social networks and messaging applications (64 %) to collaborate with peers and virtual tools to share documents (64 %). In addition, 61 % turn to teachers via online platforms when faced with academic doubts, which is evidence of a combination of independence and seeking expert guidance.

2. Benefits of using personal learning environments

Students identified multiple benefits of using PLEs in their distance learning. One of the most valued is flexibility; they can organize their schedules and access study materials anytime. This autonomy allows them to adapt learning to their personal and professional responsibilities.

Another significant advantage is access to diverse resources. PLEs integrate sources such as video tutorials, academic articles, podcasts, and specialized databases, which enriches their learning process. Students highlighted that this variety allows them to approach content from different perspectives, reinforcing their understanding.

Collaboration also emerges as a key aspect. Tools such as WhatsApp groups, Moodle forums, and video calls facilitate interaction with peers and teachers, creating a sense of community despite physical distance.

Finally, PLEs allow for the personalization of learning. Students can select the formats that best suit their learning styles, whether through text, infographics, videos, or interactive exercises. This adaptability increases their motivation and engagement with the content.

3. Disadvantages in the use of personal learning environments

Despite their advantages, PLEs present challenges that students must face. One of the most frequently mentioned is difficulty communicating with teachers and peers. Delayed responses through e-mails or chats and ambiguity in activity instructions generate frustration and can affect academic performance.

Another recurrent problem is information overload. The abundance of online resources can overwhelm students, making selecting reliable and relevant materials challenging. Some participants noted that this leads them to waste time evaluating sources rather than going deeper into learning.

Dependence on technology is also a constraint. Internet connection failures, device incompatibility or malfunctioning educational platforms disrupt workflow and create stress.

Finally, the transition from a face-to-face to a virtual model is not always easy. Some students reported difficulties in organising their time, maintaining discipline without a fixed class structure and adapting to continuous assessment in digital environments.

4. Preferred digital tools for teacher-student interaction

Students expressed a clear preference for tools that facilitate synchronous and asynchronous communication with their teachers.

Videoconferencing (e.g., Zoom, Google Meet) is highly valued for resolving doubts in real-time, allowing for closer interaction and detailed explanations of complex concepts. Secondly, chats embedded in platforms such as Moodle or Blackboard are helpful for quick queries and activity tracking.

In collaboration, social networking and messaging applications (e.g., WhatsApp and Facebook Groups) are most commonly used for teamwork, sharing materials, and maintaining contact with peers. These tools are appreciated for their immediacy and ease of use.

Discussion forums also play an important role, especially in subjects that require debate or collective reflection. Students highlighted that these spaces encourage participation and the exchange of ideas.

Shared storage and editing tools (e.g., Google Drive, OneDrive) are essential for collaborative tasks. They allow the simultaneous elaboration of documents, presentations, or reports, eliminating geographical barriers.

Finally, although institutional platforms such as Moodle and Blackboard are the basis of distance education at UAT, students suggested further integrating interactive resources (e.g., automatic quizzes and simulators) to make them more dynamic.

CONCLUSIONS

The study on Personal Learning Environments (PLE) in distance education reveals significant patterns in students' digital practices, highlighting their achievements and remaining challenges. The data obtained show that:

1. Technological configuration of PLE: students have developed complex learning ecosystems where web pages (86 %) and multimedia resources (videos 42 %, interactive materials 34 %) predominate. However, a notable dependence on institutional resources persists (61 %), suggesting that full autonomy in digital learning has not yet been achieved.

2. Consolidated benefits: time flexibility (89 %) and access to diverse resources (78 %) emerge as the most valued benefits, confirming that PLE meets fundamental distance learning needs. The ability to personalize learning processes (67 %) demonstrates successful adaptation to different cognitive styles.

3. Critical challenges: three structural problems are identified:
- Teacher-student communication deficiencies (57 % report difficulties)
- Information overload (48 % spend 30 % of time validating sources)
- Technological vulnerability (52 % affected by technical failures)

4. Technology preferences: Synchronous (videoconferencing 75 %) and collaborative (shared platforms 91 %) tools are the most effective, while traditional institutional platforms show limitations in interactivity (only 49 % satisfaction).

Pedagogical implications
- There is a need to design hybrid systems that combine the flexibility of PLE with more robust support structures.
- Improved institutional communication protocols are a priority.
- Information literacy training is essential to optimise study time
- Integrating interactive tools (simulators, quizzes) could significantly increase engagement.

This study shows that PLEs in distance education represent a significant advance in personalizing learning but require substantial improvements in their social and technical components to reach their full potential. The findings suggest that the future of virtual education should focus on creating more balanced environments where student autonomy is complemented by more effective support systems and more stable technological resources.

RECOMMENDATIONS

1. Conduct digital surveys at the beginning of the course to identify the tools and platforms that students already use.
2. Implement strategies for teachers to learn about their students' learning styles and environments.
3. Design content and tools based on these styles and environments.
4. Distribute activities according to learning objectives, avoiding overload.
5. Integrate more videos made by teachers, given the trust that students place in them.
6. Apply assessment tools for learning environments on an ongoing basis to optimise teaching in distance education.

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FINANCING

CONFLICT OF INTEREST
The authors declare that there is no conflict of interest.

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