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Innovación Educativa y Tecnológica: Retos y Oportunidades

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Content

1

PRESENTATION

Dr. Raúl de León Escobedo

2

EDITORIAL

Avances y Desafíos en la Investigación Educativa

Dra. Miriam Janet Cervantes López

3

ORIGINAL ARTICLE

Design of a prototype for students with hearing limitations

Dr. Juan Carlos Ramírez Vázquez, Dra. Guadalupe Esmeralda Rivera García, Juan Martín Maldonado Gómez, Luis Pérez Avendaño

13

Virtual communication and internet tools as a facilitating instrument for school learning

Lic. Jorge Antonio López Aguilar, Tamara Crespo Salcedo, Ángela Aracely García Zaleta, Francisco Iván Rodríguez Rodríguez

21

Learning styles and their relationship with academic performance in students of the medical surgeon degree

Dr. Wilberto Sánchez Márquez, Gema Xiomara Ávila Garza, Ana Valeria Mejía Ayala, Ian Yael Contreras Hernández

30

Culture of digital literacy in university students

Dra. Miriam Janet Cervantes López, Dr. Arturo Llanes Castillo, Ricardo González Sánchez, Olivia Mayté Cruz González

41

Impact of WhatsApp messages in the promotion campaign of the ITSTa Computer Systems Engineering Educational Program

Mtro. Jesús Bladimir Hernández Hernández, Mtra. María Xóchitl Altamirano Herrera, Mtro. Juan Antonio Enríquez Hernández

51

STATISTICS IN MEDICAL EDUCATIONAL RESEARCH

brief historical overview of statistics

Dr. Gerardo García Maldonado, Dr. Wilberto Sánchez Márquez, MPSS Brenda Daniela Gaytán Mendoza

64

CULTURAL PERSPECTIVES: BOOK AND ART REVIEWS

Life stories during the pandemic

Dr. Rosalino Amador Alonso

Distinguished members of the academic community

It is an honor to present the first edition of the CIE Journal of Educational Research from the Faculty of Medicine of 'Tampico 'Dr. Alberto Romo Caballero' at the Autonomous University of Tamaulipas. This publication not only represents progress in the academic field but also serves as a fundamental space reflecting our institution's commitment to building an educational system that meets the demands and transformations required by our current society, as outlined by our Rector, Master in Science Dámaso Leonardo Anaya Alvarado, through his Institutional Development Plan 2024-2028 in Axis 3. Research with Social Impact. The goal is to promote the training and updating of high-level specialists in scientific, humanistic, technological, and socio-economic research who contribute to the construction of comprehensive biosafety for solving priority problems in the state of Tamaulipas and nationally, including climate change, thus contributing to social well-being.

The training of competent professionals is not only a technical issue but also a matter of public policy, as the development of ethical, social, and collaborative work skills is essential to ensure that new generations face the country's challenges with responsibility and critical vision. Quality education is undoubtedly one of the fundamental pillars to achieve a more just and equitable society. That is why, at this moment when educational decisions are deeply linked to the social, economic, and political development of our nation, educational research takes on crucial relevance.

This first edition of our journal brings together research that addresses key issues for educational

transformation, not only from an academic perspective but also as a response to the structural problems facing the educational system in Mexico. The contributions presented here focus on generating concrete proposals aimed at strengthening educational quality and adapting our pedagogical models to current challenges, promoting greater social and technological inclusion, and training professionals capable of leading in their respective fields.

I would like to acknowledge the collective effort of everyone who made this publication possible. This project is a clear example of how academia can actively contribute to the development of more coherent educational policies that are aligned with the country's needs. We thank the collaboration of colleagues and experts who have enriched this process with their contributions. As an institution, we are committed not only to educational excellence but also to the construction of a system that promotes equity and progress. That is why, through the CIE Journal of Educational Research, we reaffirm our commitment to continue being a reference in generating knowledge that contributes to collective well-being and the continuous improvement of education in our region and our country.

We invite all stakeholders in the educational sector to join this project, let us unite as a region, and I urge you to contribute to the creation of new proposals that respond to the emerging challenges in the political, social, and educational context. We are convinced that only through research and critical analysis can we forge a more promising future for our communities.

Sincerely

Dr. Raúl de León Escobedo

Director



Advances and Challenges in Educational Research

We are pleased to present the first edition of the CIE Journal of Educational Research from the Faculty of Medicine of Tampico 'Dr. Alberto Romo Caballero' at the Autonomous University of Tamaulipas. This publication arises as an academic space for the dissemination of studies, experiences, and reflections on teaching and learning in the educational field, which, in recent decades, has shown significant growth in the generation of knowledge and the implementation of pedagogical innovations.

Education faces unique challenges that require constant attention and a critical approach, as the complexity of training professionals lies not only in the transmission of theoretical and practical knowledge but also in the need to develop ethical competencies, communication skills, and teamwork, all essential elements for the comprehensive care of the community. In this context, educational research plays a fundamental role by providing the foundation for the design, evaluation, and continuous improvement of educational programs in institutions.

This first issue contains a series of articles and essays that reflect the diversity of topics and approaches that characterize and enrich the fields being developed through the Center for Educational Research. Each one offers a renewed perspective in the construction of a more inclusive, technological, and humanistic educational landscape. Our goal is to continuously promote research and the development of new projects that contribute to enhancing educational quality, and

consequently, the training of committed and competent professionals who meet the needs of the current context.

The process of creating this journal has been a collaborative effort between faculty members, researchers, and students, who, with their dedication and commitment, have contributed to the creation of a product of high academic quality. We deeply appreciate the support of the academic community of the Faculty, as well as our colleagues from other institutions, whose reviews and suggestions have enriched the content presented.

Looking toward the future, we face the task of continuing to strengthen this dissemination space and further promote educational research within our institution. We invite all members of the academic community to actively participate in this project by submitting their work, engaging in the peer review process, or proposing new lines of research that address emerging challenges in education.

Finally, we reaffirm our commitment to academic excellence and educational innovation. We are confident that the CIE Journal of Educational Research from the Faculty of Medicine of Tampico will become an essential reference for those seeking to improve the quality of education and, with it, contribute to the well-being of our society.

Sincerely

Dra. Miriam Janet Cervantes López

Editor-in-Chief

Design of a prototype for students with hearing limitations

Diseño de un prototipo para estudiantes con limitaciones auditivas

Juan Carlos Ramírez Vázquez, Guadalupe Esmeralda Rivera García, Juan Martín Maldonado
Gómez, Luis Pérez Avendaño*

Abstract

In the field of educational inclusion, the creation of accessible technologies has become essential to ensure an equitable learning experience for all students. Specifically, college students with hearing impairments face unique challenges in the academic environment, where effective communication and access to information are crucial. This study focuses on the design and implementation of a technological prototype specially designed to meet the needs of this group of students from the Pánuco Higher Technological Institute. The "Top-Down" methodology was used, which seeks to solve minor problems and then address the main problem. As a result, a functional prototype is presented that has been tested on students, who provided positive feedback regarding the improvement of their listening ability. It is concluded that technology can enhance the inclusion of students with disabilities through tools that support their learning process.

Keywords: amplifier; hearing impairment; hearing problems; students; university students

Resumen

En el ámbito de la inclusión educativa, la creación de tecnologías accesibles se ha vuelto esencial para asegurar una experiencia de aprendizaje equitativa para los estudiantes. Específicamente los estudiantes universitarios con discapacidad auditiva enfrentan desafíos únicos en el entorno académico, donde la comunicación efectiva y el acceso a la información son cruciales. Este estudio se concentra en el diseño e implementación de un prototipo tecnológico especialmente diseñado para atender las necesidades de este grupo de estudiantes del Instituto Tecnológico Superior de Pánuco. Se empleó la metodología "Top-Down", que busca resolver problemas menores para luego abordar el problema principal. Como resultado, se presenta un prototipo funcional que ha sido probado en alumnos, quienes brindaron retroalimentación positiva respecto a la mejora de su capacidad auditiva. Se concluye que la tecnología puede potenciar la inclusión de estudiantes con discapacidad mediante herramientas que apoyen su proceso de aprendizaje.

Palabras clave: amplificador; discapacidad auditiva; problemas auditivos; estudiantes; universitarios

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INTRODUCTION

In the broad educational landscape, each student undertakes a singular journey, marked by challenges and opportunities, where the inclusion stands as a fundamental principle that aims to ensure everyone, regardless of their capacities or limitations, has equal access to a high-quality education (Cruz et al., 2023). Regardless of the progress in terms of inclusion, significant challenges remain to specific vulnerable groups, like university students with a hearing impairment, who can face additional obstacles that make their academic experience harder and their full incorporation into academic life (Valdiverso, 2023).

According to the World Health Organization (WHO), hearing impairment is defined as a decrease of the hearing capacity with a threshold above 25 decibels. Statistics indicate that approximately 5% of the world's population, equal to 466 million people, suffers from some kind of hearing impairment, including 34 million boys and girls. It is estimated that, for 2050, 2500 million people will have some degree of hearing loss and at least 700 million will need rehabilitation (WHO, 2023).

In Mexico, about 2.3 million of people have a hearing impairment, being over the 50% people older than 60 years old, around the 34% between 30 and 59 years old, and approximately the 2% are children (INEGI, 2020). The Convention on the Rights of Persons with Disabilities emphasizes, in their general principles, the importance of an effective and full inclusion and participation in all the spheres of life. Considering that education is an essential function,

adhering to these principles is crucial when planning formative activities. Therefore, educational institutions must implement strategies to help students overcome the difficulties they could encounter regarding their environment. (ONU, 2006).

According to Márquez & Cueva (2020), the growing acknowledgment of social inequality and the progressive reinforcement of the human rights, particularly in terms of the right to education, equal opportunities, and diversity, has driven the development and uptake of the concept of inclusion in a contemporary society. Inclusive education is defined as a pedagogical approach that values diversity as an enriching element to the educational process, thus, beneficial to human development (Maya et al., 2023). According to UNESCO, an inclusive perspective in education involves considering the individual requirements of students, ensuring their participation and success as a group. This approach recognizes the individuality of each person in terms of characteristics, interests, abilities and learning needs, in addition it pays particular attention to those students in risk of marginalization, exclusion or poor performance. (Arévalo & Mendoza, 2023).

The Organization of Ibero-American States for Education, Science and Culture, conceives the inclusion in education as a process destined to ensure the right of all the students to get a high-quality education, with particular emphasis in those in situations of higher vulnerability (Martins & Gordillo,

2022). This principle is sustained by the Article 3 of The Political Constitution of the United Mexican States, the same that establishes the universal right to education. However, plenty educational institutions still lack inclusive classrooms, technology, or infrastructure, which perpetuates the inequality in opportunities (GOBIERNO, 2021).

Consequently, it is essential that inclusive values are deeply ingrained in the tissue of educational institutions. Nevertheless, despite the scientific advances, there exists a considerable gap between the needs of the environment and the needs of academic administration (Reimers, 2022). In that sense, students with hearing impairment face particular challenges to interact with people and their surroundings, which can lead to discriminatory situations (Montoya, 2021)

Hearing loss impacts the capacity of a person to perceive sounds at different levels, which may complicate speech comprehension and oral communication. In the university environment, where interactions are based on real-time oral communication, students with hearing impairment may face significant challenges to fully participate in the educative process (Peñaloza et al., 2023).

University, as an institution dedicated to intellectual development and the pursuit of knowledge, should be friendly and inclusive to all students, independently from their abilities or limitations. However, for those with hearing impairment, reality can be highly different (Vélez & Majarrés, 2020). The

lack of access to auditory information and the limitations in communication can turn the classroom into a hostile environment, where active participation and academic commitment are obstructed by linguistic and technological barriers (Espitia & Murcia, 2023).

Technology has been a crucial ally in the search for solutions for people with disabilities, offering tools and resources that ease communication and access to information (Toala et. al., 2023). Nowadays, there are technological tools designed for inclusive education in existence, which make the education accessible to people with hearing impairment. These tools can improve communication between teachers and students under these circumstances, some of which include:

- **"Breaking Sound Barriers"**: A mobile application and website which seeks to encourage the inclusion of young people with hearing impairment in educational environments, offering real-time transcriptions of the lectures given by teachers. Furthermore, it allows students to take notes, ask questions, participate in discussion forums, and more (Telefónica, 2018).
- **"Google Meet"**: Allows subtitles in the course of calls, facilitating comprehension during video conferences (Google, 2023).
- **"Amazon Transcribe"**: This automatic speech recognition (ASR) service simplifies the conversion of voice into text in apps and it is also used to subtitle.

It allows tagging people during conversations or meetings, making it easier for students with hearing impairment to identify them (Amazon, 2023).

- **"Google Live Transcribe"**: A Google project that transcribes speech in real-time on Android devices, in over 70 languages, and notifies about sounds in the user's surroundings (Google, 2019).

- **"Petralex"**: A mobile app that is adjusted automatically to the user's hearing level, taking advantage of the smartphones technology to provide a maximum amplification of sound, similar to a conventional hearing aid (Petralex, 2023).

- **"Háblalo"**: A tool designed to help people with hearing impairment to communicate, where the user writes a text message while the app reproduces it, allowing the other person to hear and answer, with the app transcribing the message back to the user with hearing impairment (Technologies, 2021).

- **"Apple Accessibility Hearing"**: Includes a set of tools for subtitles, noise cancellation in loud environments, video communication in high definition for sign language, and RTT (Real-Time Text), a technology that enables an instant transmission of messages as they are typed. Additionally, it offers support for braille displays in all devices (Apple, 2023).

This research describes the progress of a technological prototype, specifically intended for university students with hearing impairment. This

development has an outstanding importance on both the educational and the social fields since its implementation can mean a remarkable contribution to promoting educational inclusion and equality of opportunities in the university setting. When promoting accessible tools and resources, this development aims to build a more favorable environment for the learning and the academic development of this group of students.

METHODS, TECHNIQUES, AND INSTRUMENTS

A "Top-Down" hardware design methodology was implemented, which is a hierarchical and structured approach used in complex hardware systems development. This method starts with a vision of the global system and progressively decomposes its components until it reaches more specific details. By doing so, it allows designers to obtain a complete and coherent comprehension of the system from the beginning, which makes easier the recognition of requirements and the amplification of the system's architecture.

The "Top-Down" approach offers a mindset oriented to, first, solve minor issues, and then, to integrate them to address the main problem. Based on this premise, the following sequence was established for the prototype's development:

1. A systematic analysis of literature was conducted with the aim of gathering, evaluating, and synthesizing existing research, along with

prototypes that deal with problems similar to those intended to be solved.

2. Development stages

- **Microphone:** This stage consists of an electronic system that includes an integrated microphone, connected to an audio pre-amplification system. Its purpose is to filter and enhance the speaker's voice to send it through an audio amplifier.

- **Audio Amplifier:** This stage is characterized by increasing the flow, therefore, the power of the electric signal coming from the pre-amplifier. Moreover, it enables the capacity to connect it to speakers to reproduce the analyzed audio.

- **Bluetooth Multipoint Audio transmitter and receiver:** This device allows the reception of the audio from the amplifier system and sends it via Bluetooth to compatible wireless earphones, allowing the receiver (a person with hearing impairment) to listen in a more customized way what the speaker says.

- **Bluetooth wireless headphones:** These devices receive the audio from the Bluetooth transmitter and receiver, allowing the receiver (a person with hearing impairment) to listen in a more customized way what the speaker says.

- **Smartphone or electronic tablet App:** Through these electronic devices, the signal is received from an IP camera integrated on an application developed in Android Studio. Furthermore, a Google service has been incorporated named "Live Transcribe +"

(speech-to-text translator) with the purpose of making possible to visualize in a text what the speaker is discussing.

In figure 1 are presented the stages for the development of the complete prototype, providing a general vision of the operating process. This process implies capturing the voice through a microphone, whose audio signal is then increased by an amplifier previously developed in a board. Subsequently, this signal is transmitted through a Bluetooth multipoint audio transmitter/receiver module and directed towards the headphones, responsible for converting the amplified electric energy into acoustic energy.



Figure 1. Prototype operation model.

RESULTS AND DISCUSSION

With the objective of confirming the correct operation of the hearing prototype, the following procedure was used:

An audio pre-amplifier was used to improve the signal from the microphone. This electronic device is responsible for filtering the signal to ensure it reaches the audio amplification stage in the best condition. The schematics and the audio pre-amplifier are presented in figure 2 and 3, respectively.

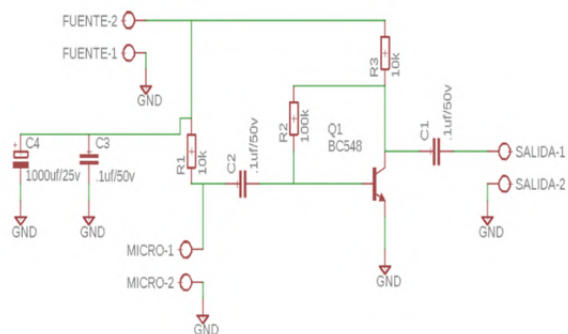


Figure 2. Pre-amplification electronic diagram.

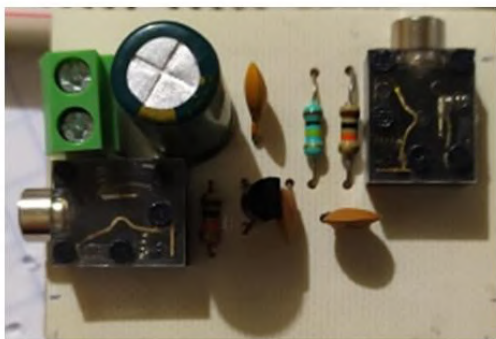


Figure 3. Audio pre-amplification circuit.

The amplifier circuit was initially evaluated on a protoboard and subsequently crafted on a phenolic board. The circuit, shown in figure 4, achieves successfully the adjusting of the transmitted audio signal from a microphone. Also, the speakers were connected to the circuit, allowing the reproduction of the professor's voice located at the front of the class.

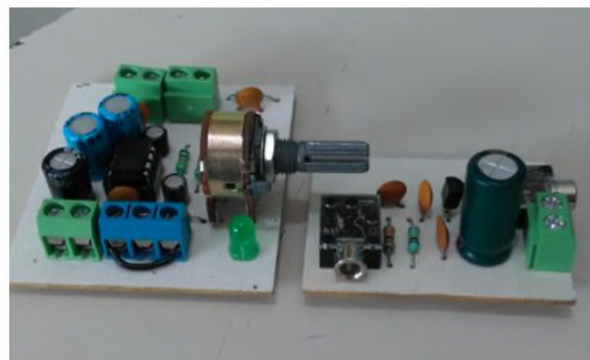


Figure 4. Finished amplifier circuit.

The mobile app developed with Android Studio provides the user with the capacity to transcribe the audio signal (Figure 5). On top of this feature, a video cam was added in the classroom to let the student visualize the images from the board from different angles and follow up the academic topic covered. The application consists of two screens, deployed to meet the user's needs. By pressing the microphone icon, the user can access a screen where an audio signal can be sent for transcription. On the other hand, the video icon provides the option to connect an IP camera to see the classroom's board.



Figure 5. Mobile app developed on Android Studio.

To evaluate the effectiveness of the prototype, some tests were conducted with the help of an electronic engineering student with hearing impairment. The student said that “his auditory capacity improved significantly.” Currently, the prototype is on a testing phase, since it is fundamental to consider different parameters based on the communication needs of the students with hearing impairments, as well as the opinion of experts like audiologists and otorhinolaryngologists. For the next stage, it is planned to evaluate the prototype with 15 students from the Instituto Tecnológico Superior de Pánuco who have hearing impairment: 9 women and 6 men.

Recent studies have explored the use of advanced hearing aid technology in educational environments. A study conducted by Smith et al. (2019) researched the impact of advanced headphones in university students with hearing loss, showing a significant improvement in speech understanding in noisy environments.

On the other hand, García et al. (2021) examined how assisted listening devices that are connected to Wi-Fi networks improved the quality of sound in the classroom, providing a better understanding of the lessons and decreasing listening fatigue.

Technology has also allowed the development of more sophisticated headphone prototypes, like the smart hearing aid designed by Kim et al. (2020), which uses artificial intelligence to automatically tune the sound levels depending on the environment and the hearing preferences of the user. Additionally, the incorporation of augmented reality technologies with headphones, as researched by Li et al. (2022), provides an immersive and educational experience.

The impact of hearing prototypes on the academic performance of students has also been studied. Johnson et al. (2021) found that the use of assisted listening devices led to significant improvements in grades and class participation of the university students with hearing impairment, emphasizing the importance of auditory information accessibility to academic success.

CONCLUSIONS

The reviewed analysis highlights the importance and the potential of hearing prototypes to improve the educational experience of university students with hearing impairment. The implementation of advanced technology, such as artificial intelligence and augmented reality, opens up new opportunities for the development of devices that not only improve

hearing, but also adapt to the individual requirements of the students.

Technology offers a significant path to enhance the inclusion of students with impairment, to provide tools that support their learning process. The implementation of these tools in classrooms is crucial, since it allows the incorporation of digital resources that enrich the educational environment and promote an inclusive learning experience. This approach considers the student's diversity in the institution and helps to change the learning environment, resulting in better academic performance.

The presented prototype emerges as an effective option for the educational environment, working as an enhancing classroom communication tool. This technological assistance not only enhances the teaching-learning process, but widens the opportunities for people with hearing impairment, by easing clear and effective communication. This helps students to fully participate in academic activities, improving their integration and academic success.

However, as the research and development of this field continues, it is essential that educational institutions consider the implementation of these technologies. These are not only beneficial for students with impairments but also promote a diversity and inclusion culture inside the educational institution.

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Virtual communication and internet tools as a facilitating instrument for school learning

La comunicación virtual y las herramientas de internet como un instrumento facilitador del aprendizaje escolar

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Abstract

Internet tools offer a wide range of educational resources adaptable to different learning styles, which allows students to learn at their own pace and in a more personalized way, they also encourage the development of critical digital skills for the 21st century, such as digital literacy, online research and information management. The objective of this work is to evaluate the understanding and application of virtual communication and internet tools of the students of the Instituto Liceo Franco Americano Preparatory Division. This is a descriptive quantitative study applied to 66 students in the first, third, fourth and fifth semester. Research shows that virtual communication allows for more constant and accessible interaction between students and teachers, facilitating collaborative learning and academic support outside the traditional classroom.

Keywords: Internet; virtual communication; learning; virtual tools; students

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Resumen

Las herramientas de internet ofrecen una amplia gama de recursos educativos adaptables a diferentes estilos de aprendizaje, lo cual permite a los estudiantes aprender a su propio ritmo y de manera más personalizada, además fomentan el desarrollo de habilidades digitales críticas para el siglo XXI, como la alfabetización digital, la investigación en línea y la gestión de la información. El objetivo de este trabajo es evaluar la comprensión y aplicación de la comunicación virtual y las herramientas de internet de los alumnos del Instituto Liceo Franco Americano División Preparatoria. Se trata de un estudio cuantitativo de tipo descriptivo aplicado a 66 alumnos de primero, tercero, cuarto y quinto semestre. La investigación demuestra que la comunicación virtual permite una interacción más constante y accesible entre alumnos y profesores, facilitando el aprendizaje colaborativo y el soporte académico fuera del aula tradicional.

Palabras clave: internet; comunicación virtual; aprendizaje; herramientas virtuales; estudiantes

INTRODUCTION

In the current digital era, the virtual communication and the internet tools have radically transformed the way school learning takes place (Padín, 2023); in an increasingly globalized and digitized world, these tools have not only transformed classroom dynamics, but also expanded the boundaries of knowledge, enabling learning to transcend traditional physical and temporal constraints (Beltran, Piracoca & Romero, 2024). The digital revolution has introduced profound changes in all aspects of society, and education is no exception; the educational environment has experienced a significant metamorphosis with the incorporation of digital technologies, since education traditionally developed in a delimited physical space, with face-to-face interactions between teachers and students (Araque, 2022). However, the introduction of virtual communication has blurred these boundaries, allowing the creation of virtual classrooms where learning is not restricted by geography (Velez & Zambrano, 2022).

Integrating technology into the educational process has enabled traditional classrooms to become more interactive and collaborative learning environments, since through platforms for video conferencing, such as Zoom and Microsoft Teams, and learning management, such as Google Classroom and Moodle (Iza & Sisa, 2024), educators can teach online classes, make assessments, and maintain constant communication with their students, being especially valuable in situations such as the COVID-19 pandemic, when in-person classes were disrupted and

online education became a necessity (Barráez, 2020). These tools not only enable distance learning, but also encourage interaction and collaboration between students from different parts of the world (Gómez, 2023), for instance, online discussion forums, collaborative cloud projects and video conferencing have become essential components of modern learning, promoting more active participation and richer brainstorming (Huamán et al., 2022).

One of the main benefits of internet tools is access to a vast number of educational resources, digital libraries, academic databases and massive open online courses (MOOCs) have democratized the access to knowledge (Herrera 2020), allowing students of different socioeconomic status from all over the world to access high-quality materials that were previously restricted to elite institutions (Julca et al., 2022). Also, online learning platforms, like Khan Academy, Coursera and edX, offer free and paid courses in a wide range of disciplines, from science and math to humanities and the arts (Pinzón, 2020), allowing students to supplement their formal education, deep dive into topics of special interest and acquire new skills at their own pace, promoting the potentialization of self-learning and autonomous learning, which contributes to the development of a culture of continuous learning (Vite & de Castillo, 2021).

The digital tools have enabled a greater personalization of learning, adapting educational content to the individual needs and rhythms of students, since using artificial intelligence

technologies and machine learning algorithms, educational platforms such as Duolingo and DreamBox can adjust exercises and lessons based on each student's progress and difficulties (Sanchez, 2022). This personalization improves learning effectiveness and also increases student motivation and engagement by feeling more supported and understood in their learning process by providing an educational experience that fits their particular needs (Argudo & Ortega, 2022).

In the 21st century, digital literacy has become an essential competence; currently the everyday use of internet tools in the educational field prepares students for an increasingly digitized work world, as through the everyday use of online educational platforms, students develop technical and digital skills that will be crucial in their future professional life such as email and video calls (Rubio & Balda, 2024). In order to collaborate on online projects, it develops effective communication and teamwork competencies that are highly valued in the work market, fostering self-discipline and accountability, key competences for both academic and professional success (Organista & Reyes, 2024).

Despite the many benefits, integrating virtual communication and internet tools into education also poses challenges (Talavera et al., 2024); the digital divide is a major concern, as not all students have access to quality internet connections and devices, so this inequality can limit learning opportunities and exacerbate educational differences (Cervantes, Peña & Ramos, 2020). In addition, overexposure to

screens and lack of face-to-face interaction can have negative effects on students' physical and mental health, so it is essential to develop strategies that mitigate these risks and ensure that technology is used in a balanced and sustainable manner (Gutiérrez, 2020). Hence the importance of what causes clear and complete communication in the analysis, study and understanding of virtual communication and internet tools as the basis for an evolved, current, and innovative education that is more demanding every day (Arenas et al., 2023).

METHODS, TECHNIQUES, AND INSTRUMENTS

The type of study is quantitative, since it evaluates the importance of virtual communication and internet tools, characterized as vitally important for an increasingly revolutionized and cybernetic world that demands their use in certain sectors essential for existence in the world of knowledge, as part of mankind and as a foundation to its preparation for his daily life and dealing with the world.

This study is limited to the Instituto Liceo Franco Americano, which has a population of 66 students. The sample consisted of first, third, fourth and fifth semester high school students enrolled in the 2022-3 period, for a total of 44 students. The instrument applied is a test prepared by the Online Training Institute. This measures the learning acquisition aptitude of the students and uses a Likert scale to rate from 7 (sufficient) to 10 (excellent).

To do an in-depth analysis of the student's knowledge, both prior and obtained, the assessment was divided into two parts, in order to make a comparison between them at the end of the study to determine if virtual communication and internet tools are instruments that facilitate school learning. The initial instrument indicates the degree of knowledge the student has prior to the study and the final instrument indicates the trends of learning and knowledge acquisition by the students. The results were analyzed descriptively in the SPSS statistical package version 22, organizing them using frequency and percentage tables.

RESULTS AND DISCUSSION

In relation to the results obtained in the initial instrument, it was found that 91.0% (40) of the students use the internet and virtual communication tools to prepare their homework or school assignments (figure 1); 75.0% (33) have a high of knowledge about Computer equipment handling (Figure 2); 86.0% (38) have more than two years using these instruments (Figure 3); 95.0% (42) are committed to put some extra effort to acquire more knowledge and learning during the course (Figure 4); regarding the skill in handling these tools, 86.0% (38) are good at them (Figure 5)

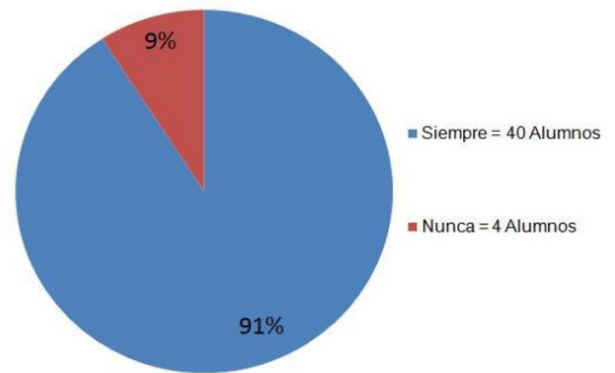


Figure 1. Using the Internet and Virtual Communication Tools

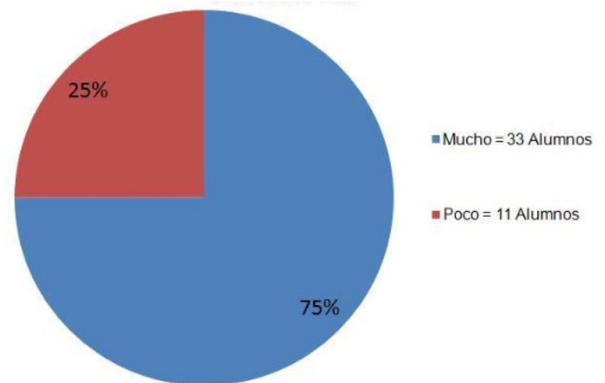


Figure 2. Computer Handling and Use Knowledge

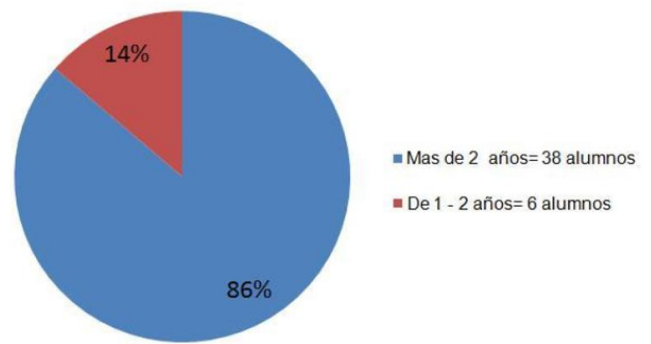


Figure 3. Experience using internet tools.

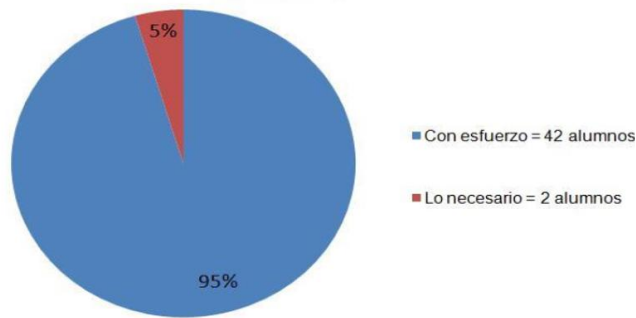


Figure 4. Student engagement for course development

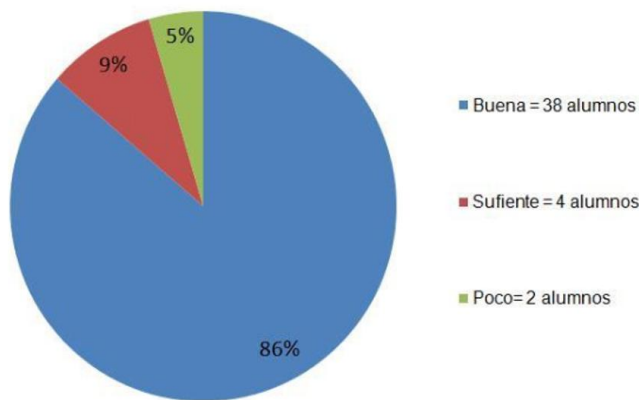


Figure 5. Students' ability to manage internet tools and virtual communication.

In relation to the degree of usefulness or effectiveness of the students' performance according to the applied assessment instrument, the results of the knowledge acquired after the course on the use of internet tools and their application in the development of school activities were analyzed, resulting in:

95%.0 (42) of students consider the use of the internet and virtual communication tools extremely useful, and 5.0% (2) as useful, therefore all students agree that these tools are useful in the performance

of their homework and school assignments. Regarding the use of the different tools and software, 86.0% (38) mention that they found it easy, 9.0% (4) quite easy and 5.0% (2) difficult. The responses obtained regarding the tools most used in the preparation of homework and assignments: 95.0% (42) responded that the software reviewed during the course and 5.0% (2) were on the Internet.

Regarding initial knowledge, learning and final knowledge, 80.0% (35) achieved a high degree of learning proficiency in the course of internet tools and virtual communication, 18.0% (8) achieved a good degree and 2.0% (1) a low degree; in terms of their opinion on what was missing for a higher learning, 75.0% (33) responded that more time than dedicated and 25.0% (11) that there were topics missing; about the question related to the level of learning from the use of tools and software seen, 79.0% (35) learned very good, 16.0% (7) excellent, and 5.0% (2) good.

95.0% (42) consider that internet tools and virtual communication are very necessary for the preparation of homework and school assignments and 5.0% (2) consider them necessary; In relation to the skills level acquired after the course, 79.0% (35) responded that they acquired very good skills in the management and use of internet tools and virtual communication, 16.0% (7) excellent skills and 5.0% (2) good skills. Regarding the learnings acquired in the course of internet and virtual communication tools, 84.0% (37) obtained a very good proficiency as shown in figure 6.

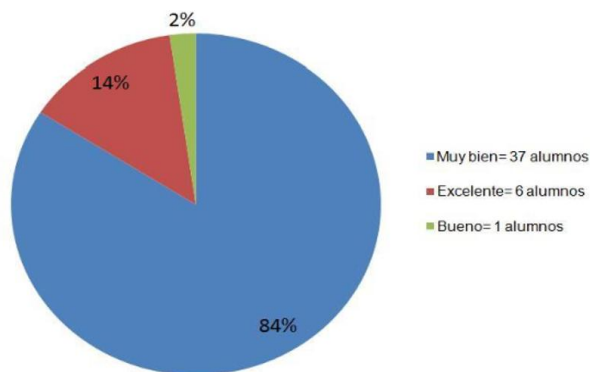


Figure 6. Learnings gained in the course of online tools and virtual communication.

CONCLUSIONS

In recent decades, virtual communication and internet tools have revolutionized the educational field, transforming the way students access knowledge and relate to learning. These technologies have proven invaluable instruments to ease school learning, offering a wide range of resources and opportunities that enrich educational experience.

One of the most significant advantages of online tools is unlimited access to educational information and resources; online educational platforms, digital libraries and academic article repositories allow students to access high-quality materials from anywhere, anytime. This access not only broadens the horizon of knowledge available to students but also encourages self-management and autonomy in learning; also, the availability of multimedia resources such as educational videos, interactive simulations and podcasts, enriches understanding of complex concepts, and supports diverse learning styles.

Virtual communication facilitates interaction and collaboration between students and teachers, removing geographic and time barriers; online learning platforms, like Google Classroom, Moodle and Microsoft Teams, allow the creation of virtual classrooms where students can participate in discussions, share ideas and collaborate on projects in a synchronous and asynchronous way; these tools encourage a more engaging and collaborative learning, where students can benefit from collective knowledge and develop effective communication and teamwork skills.

The internet tools also enable learning customization, adapting to the individual needs and rhythms of each student; adaptive learning environments use algorithms and data analysis to provide content and activities that match the student's level of skill and progress. This allows differentiated and effective teaching, where students can move forward at their own pace and receive personalized feedback; also, the possibility to access a variety of online courses and materials allows students to explore their interests and strengthen specific areas of knowledge.

The use of virtual communication and internet tools in the school environment also contributes to the development of digital competences, essential in the contemporary world; students learn to use a variety of technologies, search and evaluate information online, and communicate effectively in digital environments. These skills are crucial not only to academic success, but also to their future professional and personal life. Despite the many benefits, it is

important to recognize and address the challenges associated with integrating these technologies into school learning, such as the digital divide, online privacy and security, time management, and distraction are aspects that require attention.

It is critical that educational institutions and teachers adopt balanced approaches, providing the right infrastructure, promoting the best practices in the use of technologies, and supporting students in the development of self-regulatory skills and digital responsibility. Virtual communication and internet tools have emerged as powerful instruments that facilitate school learning, offering an unprecedented access to educational resources, promoting interaction and collaboration, personalizing learning and building critical digital skills, because by integrating these technologies effectively and thoughtfully, educational institutions can create more inclusive, dynamic and adaptive learning environments, preparing to meet challenges and seize 21st century opportunities.

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Learning styles and their relationship with academic performance in students of the medical surgeon degree

Estilos de aprendizaje y su relación con rendimiento académico en los alumnos de la licenciatura de médico cirujano

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Abstract

Learning styles refer to students' individual preferences for acquiring and processing information, VAK (visual, auditory, and kinesthetic) theory is a way to categorize learning styles based on students' sensory preferences. According to this theory, some students have a preference for visual information, others for auditory information, and others for kinesthetic information. In the context of the surgeon degree, students may show different sensory preferences in their way of learning. Some may learn best through pictures and graphs (visual style), others may benefit more from listening and verbal explanation (auditory style), and others may need to actively engage in physical practices and activities (kinesthetic style). Academic performance is the result of various factors and it is important to offer students a variety of learning strategies that address different styles and promote active and meaningful participation in the learning process.

Keywords: learning styles; academic performance; medical students

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Resumen

Los estilos de aprendizaje se refieren a las preferencias individuales de los estudiantes para adquirir y procesar la información, la teoría VAK (visual, auditivo y kinestésico) es una forma de categorizar los estilos de aprendizaje según las preferencias sensoriales de los estudiantes. Según esta teoría, algunos estudiantes tienen una preferencia por la información visual, otros por la información auditiva y otros por la información kinestésica. En el contexto de la licenciatura de médico cirujano, los estudiantes pueden mostrar diferentes preferencias sensoriales en su forma de aprender. Algunos pueden aprender mejor a través de imágenes y gráficos (estilo visual), otros pueden beneficiarse más de la escucha y la explicación verbal (estilo auditivo), y otros pueden necesitar participar activamente en prácticas y actividades físicas (estilo kinestésico). El rendimiento académico es el resultado de diversos factores y es importante ofrecer a los estudiantes una variedad de estrategias de aprendizaje que aborden diferentes estilos y promuevan una participación activa y significativa en el proceso de aprendizaje.

Palabras clave: estilos de aprendizaje; rendimiento académico; estudiantes de medicina

INTRODUCTION

Throughout the entire life cycle, people are looking for ways to obtain knowledge in the easiest feasible way according to their abilities, with the goal of consolidating learning. Over time, these ways of acquiring knowledge may change, depending on the experiences of each individual and whether or not the methods used meet their expectations; however, the role that learning styles play in the teaching-learning process should not be overlooked (Acurio et al., 2019).

For over forty years, numerous attempts have been made to develop a comprehensive theory of learning. Despite extensive studies, the results so far have not been satisfactory due to the lack of a solid explanation of how learning occurs. Some experts argue that achieving a unified theory of learning is nearly impossible due to the various ways in which learning occurs, influenced by a wide range of elements, such as cognitive, affective and motivational aspects, which are involved in the process (López et al., 2020).

The concept of learning encompasses several dimensions, is complex due to the multiple existing interactions, and is characterized by having diverse connotations. Researchers have addressed several aspects of learning, with profiles, approaches and learning styles being one of the most prominent (Puga, 2020). According to Méndez et al. (2021), identifying or recognizing the learning style of a student represents their greatest academic achievement, as it puts them on the path to the

permanent goal: how to learn. In other words, students learn more effectively when provided with learning scenarios that fit their dominant or preferred learning style, although they sometimes use multiple styles in a complementary manner.

The personality and learning style of people determine how information is perceived and processed during the educational process; these factors are crucial to the student academic performance (González, Córdoba & Forero, 2020). Depending on the learning styles, students face educational challenges using the preferred cognitive channel and adopt different strategies to solve them according to their individual style (Colpas, 2022). Neurolinguistic Programming theory suggests that information that enters each person unconsciously through the senses, but consciously is perceived through a preferred representation system, which may be linked to the sight, the hearing, or the body (Rojas & Calle, 2019).

It is important to note that each person learns in a unique way, using different strategies and learning at different speeds, with distinct levels of effectiveness, even when they share similar motivations, the same age or are studying the same topic (Segura & Quiros, 2019). Knowing how learning styles manifest in undergraduate student groups can be a valuable teaching tool to generate suitable strategies and adapt the teaching style, with the goal of achieving a better academic performance (Arroyave, 2023). In this sense, learning concepts using hypothesis-contrast

processes specific to the clinical context is ideal for good knowledge development (García, 2020).

A crucial aspect of the learning process is how information enters the brain through perceptions, leading the subject to a particular perceptual preference. Humans have three main systems to perceive information: visual, auditory, and kinesthetic (VAK), and they often use one of them more frequently (Cornejo, Desiderio & Morillo, 2019). This model, developed by Rita and Kenneth Dunn (1978), describes visual representation as the process of thinking about images, making it easier to quickly absorb information; hearing representation as the process of internalizing information through listening, in a sequential and structured order; and kinesthetic representation as the process of acquiring information through sensations and movements (Chipana & Delgadillo, 2018).

Studying a degree involves developing expertise, acquiring knowledge, abilities, skills, and competencies, in itself shaping the learnings that will be used at some point to solve problems both in the academic field and in society. A level of quality in applying this knowledge is expected, and this level is reached if the students have specific characteristics or aspects, such as their learning style, the resources available for them, their personal characteristics, the way in which they take advantage of the study time and the unique characteristics of each student. Typically, all of these aspects are reflected in academic performance (Matas, 2019).

According to Villegas, Villegas & Villegas (2018), visual students tend to have organized, orderly, observant, and calm behavior; their learning is based on what they see and often think of images. For auditory students, they usually have ease of speaking, learn through what they hear, like dialogue, remember what they hear, and think of sounds. As for kinesthetic students, their channel of interaction with knowledge is through touch, action, sensations, and they often store information in muscle memory. In a study conducted by Bojorquez & Moroyoqui (2020) with 201 dental students from the Universidad Autónoma de Juárez, learning styles were determined based on how students selected the information. 45.8% of students were categorized as visual, 29.9% as kinesthetic, and 14.9% as auditory, while the rest showed combinations of these styles.

Another study conducted by Llontop (2022) with fourth grade students, aged from 8 to 11 years, examined the relationship between VAK-measured learning styles and academic performance. In this case, 66% of students showed a hearing style, 23% a visual style, and 3% a kinesthetic style, while the rest presented combinations of them. Regarding math performance, no significant differences were found between visual and auditory styles; however, in the area of language, the academic performance showed significant differences between auditory and visual students, with the latter achieving the best grades.

The integration of VAK learning styles into the Medical Surgeon Degree curriculum can provide a more holistic and effective approach to teaching.

Fernandez et al. (2020) suggest that a balanced approach, combining visual, auditory, and kinesthetic methods, can better serve the diverse learning needs of students: this combination allows for a deeper understanding and longer-lasting retention of information.

As a result of the above, there is an increasing educational and didactic interest in learning style preferences in any group of students, using this information to adapt teaching activities, design programs and apply techniques that fit the individual characteristics of the students, in order to achieve a more efficient learning and obtain better results. In this way, it aims to optimize the educational process for the benefit of students.

METHODS, TECHNIQUES, AND INSTRUMENTS

2. Methods, techniques, and instruments

This is a descriptive study with a quantitative approach using a non-experimental, cross-sectional design. The study population is comprised of first semester students of the Medical Surgeon degree from the Universidad Autónoma de Tamaulipas (UAT) south campus, enrolled in the August-December 2023 semester; the sample consisted of 194 non-randomly selected students.

The VAK Test of the Bandler & Grinder Neurolinguistic Programming model will be used for data collection, which will be structured through the Microsoft Forms digital tool; this questionnaire

focuses on three learning channels: visual, auditory, and kinesthetic, allowing an easier understanding of the preferred ways of information input, processing, and output.

It is a model based on the Neurolinguistic Programming (NLP) system, created by psychologist and philosopher Richard Bandler and linguistics professor John Grinder, to describe the dynamics between mind and language and how it affects our body, emotions, and behavior. The aforementioned instrument is composed of 40 Likert-type items, it is an easy-to-use questionnaire, widely distributed in the field of Spanish language education and recently used in essays with undergraduate students in the area of health.

The data obtained will be concentrated in a Microsoft Office Excel data sheet, which will be ordered congruently to be subsequently processed in the SPSS statistical software version 22, systematizing the descriptive results using frequency and percentage tables.

Ethical aspects:

Para garantizar la colaboración y disposición de los participantes en la investigación se cumplirán los To ensure the collaboration and availability of participants in the study, the following ethical criteria will be met: 1) all participants will sign a consent prior to completing the instruments; 2) participants could withdraw at any time; 3) all participants will be informed of the purpose of the research and 4) there will be protection of the personal data of all

participants in accordance with the Ley Mexicana de Protección de Datos Personales (Mexican Act for the Protection of Personal Data).

RESULTS AND DISCUSSION

194 Medical Surgeon degree students were surveyed, with a gender distribution of 122 women (63%) and 72 men (37%), and an average in academic performance of 9.03 (limits: 7.30 and 10.00). Regarding the most common identifications/dominances of learning styles, kinesthetics were for a total of 113 students, visual for 57 students and auditory for 24 students, as shown in table 1.

Table 1. Identification/dominance learning styles by gender

| Learning styles | Gender | | Total |
|-----------------|------------|-----------|------------|
| | Female | Male | |
| Visual | 39 | 18 | 57 |
| Auditory | 16 | 8 | 24 |
| Kinesthetic | 67 | 46 | 113 |
| Total | 122 | 72 | 194 |

To contrast the effects of these dominances, they were grouped by academic performance as follows: Group A, equal to or greater than 9.00 (116); group B, between 8.00 and 8.99 (75) and group C, between 7.00 and 7.99 (3). See table 2.

In group A there were 82 women and 34 men, in group B there were 40 women and 35 men and in group C 3 men. Regarding the distribution by learning style in both men and women, I prefer the kinesthetic style as shown in table 3..

Table 2. Academic performance by gender.

| Gender | Group | Average | Total |
|--------|-------|--------------|-------|
| Female | A | 9.00 – 10.00 | 82 |
| | B | 8.00 – 8.99 | 40 |
| Total | | | 122 |
| Male | A | 9.00 – 10.00 | 34 |
| | B | 8.00 – 8.99 | 35 |
| | C | 7.00 – 7.99 | 3 |
| Total | | | 72 |
| Total | A | 9.00 – 10.00 | 116 |
| | B | 8.00 – 8.99 | 75 |
| | C | 7.00 – 7.99 | 3 |
| Total | | | 194 |

Table 3. Learning styles by average and gender.

| Género | Promedio | Estilo | | | Total |
|-----------|--------------|----------|-------------|--------|-------|
| | | Auditivo | Kinestésico | Visual | |
| Femenino | 9.00 – 10.00 | 7 | 45 | 30 | 82 |
| | 8.00 – 8.99 | 9 | 22 | 9 | 40 |
| Total | | 16 | 67 | 39 | 122 |
| Masculino | 9.00 – 10.00 | 3 | 21 | 10 | 34 |
| | 8.00 – 8.99 | 5 | 23 | 7 | 35 |
| | 7.00 – 7.99 | 0 | 2 | 1 | 3 |
| Total | | 8 | 46 | 18 | 72 |
| Total | 9.00 – 10.00 | 10 | 66 | 40 | 116 |
| | 8.00 – 8.99 | 14 | 45 | 16 | 75 |
| | 7.00 – 7.99 | 0 | 2 | 1 | 3 |
| Total | | 24 | 113 | 57 | 194 |

As a result of the application of the ANOVA test, no significant differences (0.98) were observed, so the learning style is not related to the academic performance of the students. A comparison was drawn through the Leneve test for the homogeneity of variances (0.093), which means that the variances of the diverse groups are the same.

In a study by Fernandez et al. (2020), the prevalence of VAK learning styles among medical students and their impact on academic performance was explored; a high percentage of students identified themselves

with the visual learning style, followed by auditory and kinesthetic; visual students showed better performance in theoretical subjects, suggesting that teaching methods including graphics, diagrams, and visual presentations may be more effective in medical education.

Academic performance relating to VAK learning styles has been the subject of several studies; Martinez, Garcia & Sanchez. (2021) studied how these styles affect academic performance in Medical Surgeon degree students, revealing that students with an auditory learning style performed better in oral exams and presentations, while kinesthetic students excelled in internships and labs; this finding suggests that adapting assessment methods to learning styles can improve academic performance.

Garcia & López (2019) study highlighted the importance of adapting instructional strategies to VAK learning styles, in order to improve educational effectiveness; the authors suggest the use of a combination of visual, auditory and kinesthetic methods to address different student preferences. For instance, lessons may include visual presentations, group discussions, and hands-on activities to ensure all students have the opportunity to learn effectively.

Implementing pedagogical strategies tailored to VAK learning styles can be challenging, but also offers numerous advantages, in a study by Johnson et al. (2020) a pilot program was described, in which instructors used diversified teaching methods to meet

the needs of students with different learning styles; the results showed significant improvement in academic performance and student satisfaction, indicating that adapting teaching strategies can be highly beneficial.

While adapting pedagogical strategies to VAK learning styles has many benefits, there are also significant challenges and limitations; according to a study by Smith et al. (2018), one of the main challenges is the lack of adequate training for teachers, coupled with the need for additional resources and the time required to develop and apply diversified teaching methods may be limiting. According to Garcia & López (2019), educator training programs should include training in diversified teaching techniques and the use of educational technologies, in order to develop in teachers the necessary skills to create an inclusive and effective learning environment; also, the implementation of diversified teaching methods can be costly and require significant investment in time and resources.

It is imperative that educational institutions implement ongoing evaluation and feedback systems to monitor the effectiveness of pedagogical strategies tailored to VAK learning styles. Martinez, Garcia & Sanchez (2021) recommends the use of formative and summative assessments to measure the impact of these strategies on academic performance and student satisfaction, as well as regular feedback to help continually adjust and improve teaching techniques.

CONCLUSIONS

The findings highlight the importance of considering different pedagogical approaches in the educational context, acknowledging that students learn in diverse ways. Although learning styles are not related to academic performance, strategies that address these differences must be promoted, ensuring an environment of inclusive instruction tailored to the individual needs of students.

The relationship between VAK learning styles and academic performance in undergraduate surgeon students is complex and significant. Reviewed studies suggest that identifying and adapting instructional strategies to learning styles can improve academic performance, information retention and student satisfaction, because, by integrating pedagogical approaches that consider the diversity of learning styles, educational institutions can train more competent and prepared health care professionals.

However, it is essential to continue researching and developing effective methods to apply this knowledge in medical education, in order to better understand how VAK learning styles interact with other educational factors and how they can be effectively implemented in different contexts.

Future studies should focus on developing teacher training programs that allow them to identify and adapt their teaching methods to VAK learning styles. In addition, longitudinal studies are needed to assess the long-term impact of these strategies on academic performance and student satisfaction.

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Culture of digital literacy in university students

Cultura de la alfabetización digital en estudiantes universitarios

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Abstract

In the contemporary era, characterized by the omnipresence of technology and the growing influence of digitalization in all aspects of life, digital literacy has become an unavoidable imperative. University students, as part of the generation that has grown up immersed in the digital world, they are at the epicenter of this transformation, so digital culture in university students represents a set of attitudes, values, knowledge and practices related to the use of technology in daily and academic life. Objective: analyze the culture of digital literacy in university students studying medicine. A descriptive, observational and transversal study was followed, the data was collected through a questionnaire in Microsoft Forms applied to 320 students, resulting in: attitude in relation to new technologies being good because the familiarity of the use of these in daily life has facilitated their inclusion in education. The use of ICT represents invaluable support for students by facilitating their research in the scientific and medical field, since it gives them the ability to search for updated information in these fields and, at the same time, develop skills in the processing and management of data.

Keywords: digital literacy; culture; students; university students

Resumen

En la era contemporánea, caracterizada por la omnipresencia de la tecnología y la creciente influencia de la digitalización en todos los aspectos de la vida, la alfabetización digital se ha convertido en un imperativo ineludible. Los estudiantes universitarios, como parte de la generación que ha crecido inmersa en el mundo digital, se encuentran en el epicentro de esta transformación, por lo que la cultura digital en estudiantes universitarios representa un conjunto de actitudes, valores, conocimientos y prácticas relacionadas con el uso de la tecnología en la vida cotidiana y académica. Objetivo: analizar la cultura de la alfabetización digital en estudiantes universitarios de la licenciatura de medicina, para ello, se siguió un estudio descriptivo, observacional y transversal. Los datos se recabaron a través de un cuestionario en Microsoft Forms aplicado a 320 estudiantes resultando que: la actitud de los alumnos en relación a las nuevas tecnologías es buena debido a que la familiaridad del empleo de estas en la vida cotidiana ha facilitado su inclusión en la educación. El empleo de las TIC representa un apoyo invaluable para los estudiantes al facilitar sus investigaciones en el ámbito científico y médico, ya que les brinda la habilidad de buscar información actualizada en estos campos y, al mismo tiempo, desarrollar habilidades en el procesamiento y gestión de datos.

Palabras clave: alfabetización digital; cultura; estudiantes; universitarios

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INTRODUCTION

In current society, it can be clearly observed the deep impact of the Information and Communication Technologies (ICT) (Flores, Ortega & Sousa, 2021), the knowledge management and the increasing trend towards globalization; this factors had a significative influence on people, as they contribute to close the digital divide and offer opportunities to develop abilities and knowledge (Barrios & García, 2022). This has generated an increasing need of what is known as digital convergence, where technological innovations are becoming more and more integrated in our daily life through a wide range of products and services, including the education, that has become an integral part of this transformation and development processes (Reyes & Avello, 2021) The incorporation of ICT on the educational field provides the opportunity to take advantage of the benefits of this technologies to improve the quality an accessibility for educational processes, promoting an interactive and nurturing approach for learning, through the use of digital resources (Cueva et al., 2023).

In today's society, digital literacy has become essential for the workplace and everyday activities of people; however, research made by Schofield et. al. (2023), emphasize that technological know-how is not a generalized thing. In this context, approximately half of the population lacks the necessary skills to use ICT, even if they had university education; besides, disparities are observed in the level of technological empowerment between different genres (Herrera & Rivera, 2020); hence, the authors argue the importance to achieving a complete

digital competence, that encompasses all aspects of literacy, including digital and technological. This does not only imply knowing how to use technology, but also understanding and critically apply information, as well as effectively benefiting from the available digital tools and technologies (Cruz et al., 2023).

DIGITAL LITERACY

The digital literacy is a concept of great relevance in current society, than encompasses the ability to perform actions in a cybernetic environment, such as looking for, research and analyze information using technology; it also implies the capacity to develop abilities to create and enhance content in virtual contexts (Amaua et al., 2023); is not just a matter of using technology as a communication media, but also to understand that it represents a new form to interact, communicate, create and understand information in the digital environment (Castro et al., 2021). The digital literacy includes a skills set that allows people to interact in an effective and responsible manner with the ICT, by taking advantage of their benefits and facing the challenges they bring, becoming increasingly crucial in a world where technology and information are fundamental elements in our daily lives (Reyes & Avello, 2021).

Nowadays, society is immersed in the digital era, in which information and learning are fundamental (Marimon et. al., 2022). In this context, information management acquires a critical importance, as it involves the accurate and appropriate selection of what is relevant and necessary, thereby strengthening the skills, competences, contexts and meanings that

encompass the complexities of this technological era (Parra & Balanza, 2020) It is essential to acknowledge that the precise definition of the scope of digital literacy still requires further clarification, since digital can cover either a tool, a technique or a service with different properties and characteristics (Barbieri & Blanco, 2020) In the current context of the information society, addressing the complexities of the digital environment demands a wide and complete concept of literacy that is not reduced to specific skills or to a specific technology or set of technologies (Espeja & Lazaro, 2022); it is crucial to consider all the forms of literacy based in abilities, but also to go beyond them, covering the whole picture of digital literacy in all its dimensions; this implies an integral understanding of the competences and necessary capacities to actively browse and participate in today's digital society (Gil, 2023).

According to Toledo (2022), the digital literacy encompasses several levels, ranging from basic skills such as posting on Instagram, to an intermediate level that implies the use of technology to enhance the daily life and increase the efficiency, up to an advanced level that requires the capacity to create original digital content. Digital literacy provides a series of meaningful benefits, including the development of critical thinking that enriches education and improves the quality of the information available, contributing as well to the enhancement of abilities and to the daily use of technology, which translates into a better quality of life. In addition, the digital literacy may open doors to better job opportunities, with perspectives and

more favorable salaries; however, it is essential to take into account the digital gap manifested due to disparities in educational, social, economic and cultural environments, from a national to a global level (Reyes & Avello, 2021).

According to Guajala et al. (2021), digital literacy has as its purpose to offer education and evaluate contents, while developing basic computer skills, allowing people to use computer tools in their daily lives and creating new opportunities, socially and economically, for them, their families, and their communities. As a result, digital literacy becomes of crucial importance, as it promotes inclusion and is closely related to the digital divide, also known as the social gap, since both influence each other, thus emerging as the key to progress in the information and knowledge society. (Social, 2022).

According to Oberländer, Beinicke & Bipp (2020), there are several definitions of the concept for digital literacy; for instance, it implies the capacity to carry out successful digital actions in various life situations, including work, learning and other everyday aspects; it varies according to the individual situation of each person, and is a process that develops and evolves as the mastery of digital skills progresses; it is a broader term than ICT literacy, since it includes elements related to general literacy, such as informational, media and visual literacy; it implies the acquisition and use of personal knowledge, techniques, attitudes and skills, and includes the capacity to plan, execute and evaluate digital actions in the resolution of daily

tasks, as well as the capacity to reflect on the development of their own digital literacy.

In accordance with the previous proposition, the definition of digital literacy can be summarized as: “Knowledge, attitude and skills of individuals to use in a proper manner the digital tools, as well as the capacity to identify, access, manage, integrate, evaluate, analyze and synthesize digital resources.” It also involves the construction of new knowledge, the creation of media expressions and the communication with others in specific contexts of life, with the objective of facilitate constructive social action and reflect on this process” (Oberländer, Beinicke & Bipp, p. 135). Digital literacy encompasses all forms of literacy needed in the 21st century society due to its multifunctionality and scope, hence its nature has led to specify its implicit dimensions, broadening its meaning in a cross-sectional manner (Montenegro, Raya & Navaridas, 2020).

METHODS, TECHNIQUES, AND INSTRUMENTS

The research was descriptive, observational, and cross-sectional, conducted at the Tampico School of Medicine “Dr. Alberto Romo Caballero,” from the Universidad Autónoma de Tamaulipas. Its population is composed of 1,240 students for the Physician-Surgeon bachelor’s degree, during the January-May of 2023 school term, distributed from the first to tenth semester, according to the information provided by the Academic Secretariat of

this institution. As for the selection of the sample, 320 students (26%) were randomly selected and voluntarily accepted to participate; data collection was carried out through a survey elaborated in Microsoft Forms, composed of 17 items that included gender and grade point average, and 15 multiple choice items that were answered anonymously with a time limit of 30 minutes.

The reliability and validity of the instrument was obtained through the analysis carried out by 5 experts in technology and innovation in ICT from the education area; reliability was determined with the application of a pilot sample to 100 students (approximately 30% of the participants in the study) and applying Cronbach alpha coefficient, which yielded a high reliability range, from 0.93 to 0.97 for the 15 questions included in the survey, and an overall value of 0.95 for the instrument; the results obtained indicated that the elimination of any of the items was not significant, hence the survey was fully implemented to the study group.

In order to analyze the collected information, the results were downloaded to a database and processed with statistic software SPSS (Statistical Package for the Social Sciences) version 22; they were interpreted by means of descriptive statistics with central tendency measures and percentages.

RESULTS AND DISCUSSION

The gender distribution of respondents was of 162 women (50.46%) and 158 men (49.54%).

Technology Availability

Most of the surveyed students have a laptop and/or smartphone, and the percentage to access internet through computer or phone is considerably high, reaching 94.68% (see table 1) This data is similar to the research carried out by Hidalgo et al. (2019), which informed that 96.8% of the surveyed students in the bachelor degree in medicine, have access to internet. Also, in both studies, personal computers were highlighted as the most used device by students, representing 82.9% in the study by Hidalgo et al. (2019) and 90.62% in this study. These results also closely match the findings of Carrillo et al. (2021), who reported an Internet access rate of 92.3%.

Table 1. Available ICT for educational activities.

| Technological support | Frequency | Percentage |
|----------------------------------|-----------|------------|
| Internet (computadora, teléfono) | 303 | 94.68% |
| Computadora portátil | 290 | 90.62% |
| Smartphone | 261 | 81.87% |
| Tableta | 161 | 50.31% |
| Computadora de escritorio | 115 | 35.93% |
| Smart TV | 108 | 34.06% |

The grade point obtained was 8.38, with a range going between 7.7 and 9.30 (table 2) All the students that obtained grades of 9 or higher (n=12) have essential resources such as a laptop, a smartphone and internet access, providing them with wide connectivity capabilities. Among the students whose grades were in the range of 8 to 8.99 (n=287), that make up the majority of respondents, 90.8% have a

laptop or smartphone; this suggests that connectivity is not a challenge for the students when it comes to accessing information, and no direct association was observed between this variable and the grades obtained.

Table 2. Student grade points average.

| Rating grade | Frequency | Percentage |
|--------------|-----------|------------|
| 9 o mayor | 12 | 3.75% |
| 8 a 8.99 | 287 | 89.69% |
| 7 a 7.99 | 21 | 6.56% |
| Total | 161 | 100% |

Education, time, and use of technology

Medical students who participated in the survey spend an average of 4 to 7 hours per day performing general educational activities; while the time dedicated to educational activities that involve ICTs, ranges from 2 to 4 hours per day. However, its important to highlight that 77% of the interviewed reported that they perform simultaneous activities while studying with ITC. The most common activities include the use of Facebook, real time internet conversations (chatrooms), as well as watching television, accounting for 51.40%, 32.10% and 21.10% (figure 1). This findings are consistent with the results of Hernández, Sánchez and Giménez (2021), who found that 59.0% of young people spend between 1 to 4 hours a day using ICT, in these time, the 43.0% is used to search for information, these results being similar to those obtained in this research. In addition, according to Santana et al. (2019), the most common communication activities between students include chatting, sending, or

receiving e-mails, and accessing Facebook or Hi5 with 37.0%..

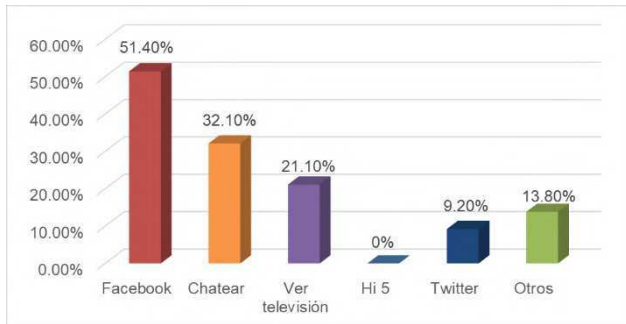


Figure 1. Activities conducted simultaneously while studying using ICT.

Education through the use of ICT

Regarding online education, 28.7% of students mentioned that they don't participate in blogs or discussion forums, 72.1% had assisted to video conferences and an impressive 90.2% have completed some online course; these findings are consistent with the research conducted by Villavicencio et al. (2019), which agrees with this study regarding participation in blogs and discussion forums, as they reported that 81.5% of students have participated in these activities, while 75.0% have attended online conferences and 87.0% have completed online courses. When asked about their preferences regarding online courses they would like to partake in, the majority expressed a preference for courses about clinical practice guidelines. (figure 2)..

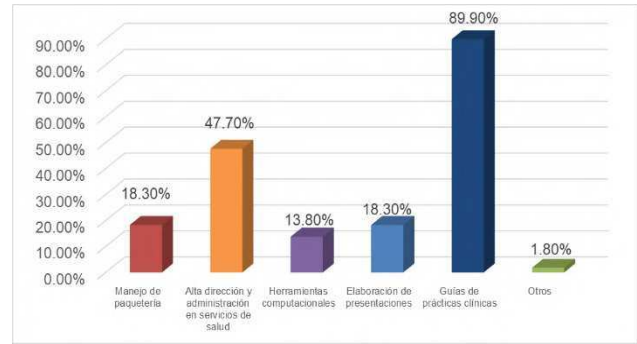


Figure 2. Online courses you would like to take part in.

Searches on scientific publications and the English language

The databases used by the students to access scientific medical information are detailed in table 3, and their order from most to least frequently used is: on the first place, Google Scholar, followed by Scielo and EBSCO. It is interesting to notice that, even though EBSCO is the more widely promoted database in the institution, due to its teaching program, students tend to prefer Google Scholar; these findings are in line with the results of Valladares et al. (2020), where OVID is mentioned as the most used database. Although specialized databases such as Scielo, EBSCO and OVID, offer advanced searching tools, students seem to opt for the convenience of Google Scholar.

It is important to highlight that most part of the indexed medical literature and the databases with relevant publications are published in English, as mentioned in Águila, De Oca Montano and Martínez (2023); hence, English fluency becomes a crucial factor for the integral learning of the medical students, since the search capacity for scientific

publications will be significantly limited without a good command of this language. In this study, it can be observed that the percentage of reading comprehension in non-specialized English reported by the students, ranges between 50% to 75%, results that are consistent with the findings of Fernández (2023), where it is indicate that 70% of students understand texts in general English.

Tabla 3. Bases de datos empleadas para obtener información científica médica.

| Database | Frequency | Percentage |
|-----------------------------|-----------|------------|
| Google académico | 247 | 77.18% |
| Scielo | 158 | 49.37% |
| EBSCO | 117 | 36.56% |
| Otros | 47 | 14.68% |
| Science Research | 44 | 13.75% |
| Microsoft Academic Research | 9 | 2.81% |

Attitudes towards new media for the acquisition of knowledge

In terms of the attitude of students towards new technologies as a mean to acquire knowledge, it is observed that the most popular preferences include reading a book (70.6%), followed by searching and reading publications on the internet (62.4%) and the option to listen a video conference (38.5%); these results are similar to those presented by Garcia, Moreno & Flores (2020), who reported a strong preference towards reading books and Internet publications. Although the familiarity with the use of ICTs in everyday life made easier its incorporation in education, the full use of these technologies in the

search for medical scientific data or information for learning is yet to be achieved.

It is important to emphasize there are numerous studies about the successful application of tools in educational area, as demonstrated by the positive results obtained in the previous studies (Ayabaca, Alba & Guamán, 2019). In an study made by Largo et al. (2022), it was found that the use of ICT in their tasks, made the students show a greater interest in them, increasing their motivation, effort and persistence: the use of technology promoted creativity, divergent thinking and provided them with successful experiences, besides encouraging autonomous learning and the adaptability to different learning rates, as pointed out by Cervantes, Peña & Ramos (2020).

CONCLUSIONS

The culture of digital literacy on college students has become a critical need in this era; in an increasingly digital world, the ability to use technology effectively is not only an asset, but an essential skill for academic and professional success, as digital literacy is not limited to a mere familiarity with technological tools, but encompasses the ability to search, evaluate, and use online information in a critical and effective manner. College students who develop these skills have a significant advantage in their pursuit of knowledge and preparation for their future careers by promoting autonomy, problem solving and adaptability, skills that are highly valued in the academic and working worlds.

Ensuring that all students have access to the digital literacy culture is a key challenge, since digital gap (economic or geographic), can leave some students at a disadvantage; therefore, educational institutions and governments must strive to provide adequate resources and promote equity in access to technology and connectivity, thereby turning digital literacy into a right that should be available to everyone. As technology continues to evolve, the college students must be prepared to face challenges such as information overload, fake news proliferation and social media addiction, while, at the same time, having the opportunity to take advantage of online educational resources, collaborate globally and contribute to innovation.

Today we live in an era of interdependence, where ICTs have reduced distances and broadened access to knowledge, which translates into a reduction of the gap between researchers and available information, leading to the creation of objects and solutions aimed at improving the quality of life for the people. Therefore, it is crucial to promote and encourage the use and integration of these technologies in the academic programs of universities.

This creates a suitable environment for students to acquire skills in technological tools that are in high demand in today's work market, therefore this approach not only prepares students to face these challenges, but also contributes to close the gap between technological progress and education, allowing more individuals to benefit from the opportunities offered by ICTs; as a result, the culture of digital literacy is considered essential for the integral development of university students in the 21st Century, since it provides them with the necessary skills for academic and professional success, promotes inclusion and equity, and encourages responsibility and ethics online. As we move forward in an increasingly digital age, digital literacy becomes a fundamental pillar of higher education and the preparation for life in modern society.

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Impact of WhatsApp messages in the promotion campaign of the ITSTa Computer Systems Engineering Educational Program

Impacto de los mensajes de WhatsApp, en la campaña de promoción del Programa Educativo de Ingeniería en Sistemas Computacionales del ITSTa

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Abstract

One of the biggest problems faced by the Computer Systems Engineering educational program of the Instituto Tecnológico Superior de Tantoyuca is related to the recruitment of new students, due to the limitations in delivering the academic offer to students due to various factors, such as: distances, transportation costs, time spent on promotion, among others. The global confinement in which we were forced to stay at home in 2020 due to COVID-19 required us to look for new strategies to deliver the promotion to students who were about to complete their high school diploma. A solution to the problem raised was the use of electronic means with which information could be sent to future prospects, making them aware of the services offered by the Computer Systems Engineering educational program. WhatsApp was used as the means of excellence for sending mass messages. Compared to 2020 where this strategy was not used, an increase in students of 200% was achieved by 2022.

Keywords: Educational program; Academic Offer; students; promotion; messages; WhatsApp

Resumen

Una de las mayores problemáticas que enfrenta el programa educativo de Ingeniería en Sistemas Computacionales del Instituto Tecnológico Superior de Tantoyuca es referente a la captación de alumnos de nuevo ingreso, debido a las limitaciones para hacer llegar la oferta académica a los estudiantes a causa de diversos factores, tales como: las distancias, costos por traslados, tiempo empleado en promoción, entre otros. El confinamiento global en el que nos vimos obligados a permanecer en casa en el 2020 a causa del COVID-19 precisó en buscar nuevas estrategias para hacer llegar la promoción a los alumnos que estaban por culminar su bachillerato. Una solución a la problemática planteada fue el uso de medios electrónicos con el que se pudo hacer llegar la información a los futuros prospectos dándoles a conocer los servicios que ofrece el Programa educativo de Ingeniería en Sistemas Computacionales. Se utilizó WhatsApp como el medio de excelencia para el envío de mensajes instantáneos masivos. En comparación con el 2020 donde no se usó esta estrategia se logró un incremento en los alumnos de un 200% para el 2023.

Palabras clave: Programa educativo; oferta académica; alumnos; promoción; mensajes; WhatsApp

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INTRODUCTION

Upon completing high school, students aspiring to pursue higher education face the challenge of selecting an institution that offers a program aligning with their interests and expectations. "The main challenges identified include the need for flexibility and updates in educational programs" (Morales & Rodríguez Pavón, 2022). However, many students lack sufficient information regarding academic offerings and institutional services, making it difficult to compare available options and make informed decisions. Furthermore, institutions often encounter challenges in effectively communicating their academic offerings due to geographical distances, high transportation costs, inaccessibility of certain areas, and the extensive resources required for promotional visits. "Social media platforms have become essential tools for promoting university academic offerings and improving communication in higher education" (Aguilar-Zambrano et al., 2023).

To address these challenges, this study focuses on the Computer Systems Engineering program at ITSTa, which has faced difficulties in recruiting new students. While ITSTa offers eight engineering programs and one bachelor's degree, several other institutions in the region also provide undergraduate programs, intensifying competition for prospective students. "The expansion of higher education offerings has led to the development of new regional concentrations, with public state universities extending their reach through satellite campuses" (Mejía-Pérez et al., 2023).

Since its establishment in 2000, the Computer Systems Engineering program did not initially experience enrollment difficulties. However, starting in 2018, enrollment figures began to decline. In 2018, 37 students enrolled, decreasing to 35 in 2019. The COVID-19 pandemic exacerbated this trend, with only 31 students enrolling in 2020—the lowest recorded intake in the program's history.

Table 1. *Historical Enrollment of New Students*

| Año | Total de Ingreso | Hombres | Mujeres |
|------------|-------------------------|----------------|----------------|
| 2000 | 118 | 51 | 67 |
| 2001 | 89 | 46 | 43 |
| 2002 | 91 | 52 | 39 |
| 2003 | 112 | 62 | 50 |
| 2004 | 96 | 66 | 27 |
| 2005 | 96 | 57 | 36 |
| 2006 | 79 | 43 | 36 |
| 2007 | 89 | 52 | 37 |
| 2008 | 75 | 49 | 26 |
| 2009 | 94 | 64 | 30 |
| 2010 | 72 | 46 | 26 |
| 2011 | 82 | 56 | 26 |
| 2012 | 52 | 38 | 14 |
| 2013 | 55 | 42 | 13 |
| 2014 | 47 | 36 | 11 |
| 2015 | 53 | 37 | 16 |
| 2016 | 38 | 25 | 13 |
| 2017 | 44 | 31 | 13 |
| 2018 | 37 | 23 | 14 |
| 2019 | 35 | 23 | 12 |
| 2020 | 31 | 16 | 15 |
| 2021 | 61 | 39 | 21 |
| 2022 | 69 | 40 | 29 |
| 2023 | 54 | 37 | 17 |

Due to these challenges and the restrictions imposed by the pandemic, this study explores the use of WhatsApp as a promotional tool. Given its widespread use and accessibility, WhatsApp allows for the efficient dissemination of promotional messages, videos, links, and other informative materials to prospective students. "WhatsApp has

emerged as a versatile tool for communication and information dissemination in various contexts" (Lantarón, 2018).

Taking advantage of the fact that the vast majority of mobile service users own a smartphone and have access to this platform, 98% of Internet users report having connected to a social network or used an instant messaging service in the past month, and 83% have actively participated in these spaces—not only by consuming content but also by creating it (Sixto García, et al., 2021).

Human behavior has evolved rapidly due to technological changes, and social platforms have become a privileged communication tool between companies and their customers (Matute Quito, et al., 2021). Through the use of WhatsApp, it is possible to reach students, thereby promoting awareness of the educational program's services while focusing on students' specific interests and facilitating interpersonal communication between the program and prospective students.

At the conclusion of the study, the results obtained from implementing the strategy of Sending Messages via WhatsApp with Information about the Educational Program during the years 2021, 2022, and 2023 were evaluated and compared with those from 2018, 2019, and 2020, when this strategy was not employed.

METHODS, TECHNIQUES, AND INSTRUMENTS

This research adopts a cross-sectional approach, which involves data collection at a single point in time, allowing for the analysis of WhatsApp as an educational promotion tool during the years 2021, 2022, and 2023.

The nature of the study was exploratory and descriptive. It aimed to understand how the WhatsApp platform impacted the promotion and communication between the Computer Systems Engineering program and high school students within the area of influence. Additionally, it described the specific characteristics of the use of this application and its effectiveness in attracting potential students to the program.

The study follows a quantitative approach, as it focused on collecting numerical data regarding the number of students who responded to the promotional messages sent via WhatsApp, as well as their conversion rate into enrollments.

USE OF WHATSAPP AS A MEANS TO REACH POTENTIAL PROSPECTS.

This research aims to provide a clear understanding of how WhatsApp can be effectively utilized by educational institutions to attract students, as well as to contribute to the development of more effective communication strategies. "The widespread use of the application among higher education students makes it a viable platform." (Pérez-Cruz et al., 2020).

This research was conducted as a response to the need to increase the enrollment of new students in the Computer Systems Engineering program at ITSTa. The initiative was led by the program's division head, particularly in the context of restrictions on in-person activities imposed by COVID-19. WhatsApp was utilized as the primary tool for this purpose. "WhatsApp has emerged as a valuable marketing tool for businesses across various sectors. It allows companies to attract customers, gain competitive advantages, and efficiently disseminate promotional content." (Goulart et al., 2019). "Socially, WhatsApp served as a virtual ally in maintaining social interactions during the quarantine through informational, conversational, and recreational messages." (Fernandes Pereira et al., 2021).

WhatsApp is a cost-effective and efficient instant messaging platform that facilitates communication between individuals or groups. Currently, a high percentage of users have access to this service on their smartphones, making it one of the most popular applications available.

WhatsApp Messenger (WA) is a messaging application for smartphones that is increasingly gaining recognition in the educational context." (Martínez et al., 2021). "As we know, WhatsApp is an instant messaging service designed to connect two or more users via the Internet in real time, at minimal cost, using text messages or files (audio, videos, images, geographic location...)." (Gómez del Castillo, 2017). Another advantage of this platform is its

compatibility with PCs and laptops through its desktop version, which further facilitates message delivery. This version supports Windows commands such as copy-paste and allows for the drag-and-drop function for sending images and files directly from the platform.

THE PROMOTIONAL CAMPAIGN PROCESS FOR THE COMPUTER SYSTEMS ENGINEERING PROGRAM AT ITSTA THROUGH WHATSAPP MESSAGING

To increase the enrollment of new students in the Computer Systems Engineering program, a promotional campaign was launched using instant messaging services. "These platforms have become essential tools for direct communication with citizens and for amplifying messages." (Cano-Orón et al., 2024).

To implement this strategy, a request was made to the ITSTa Liaison Department for a list of students enrolled in the 5th or 6th semester at high schools within ITSTa's area of influence. This region includes approximately 40 schools, comprising different educational subsystems such as CBTis, CBTa, CECyTs, COBAEV, TEVAEV, and private high schools in Tantoyuca, Plantón Sánchez, Tempoal, Chicontepec, Ixcatepec, Chontla, San Sebastián, Ixhuatlán de Madero, among others.

Once this information was obtained, the verification and analysis phase was carried out, correcting errors in names and phone numbers. The list provided

contained some inaccuracies, such as spelling mistakes and inconsistencies in capitalization. More importantly, many phone numbers did not conform to the standard format—some included blank spaces, numerical errors, or lacked the country code (+52), which is the international dialing prefix for all phone numbers in Mexico.

The processed information was recorded in an Excel spreadsheet to facilitate its management and consultation. Tables were created to organize key data, including the student's name, email address, school of origin, and WhatsApp number, to which the promotional information was sent.

To protect students' privacy and comply with ethical and legal regulations, personal data such as names, email addresses, and contact numbers have been anonymized in the tables and figures presented in this research.

information using WhatsApp Web from a PC. This method was chosen because it allows messages to be sent without the need to save students as contacts.

From a web browser on a PC or laptop, the following URL was used:

<https://api.whatsapp.com/send?phone=XXXXXXXXXXXX>

In this URL, the "X" characters represent the recipient's phone number. After entering the URL, a screen appeared displaying the information to be sent.

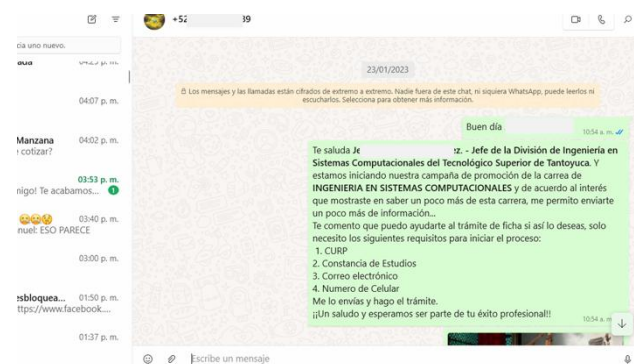


Figure 1. Information sent to WhatsApp number +52XXXXXXXXX9 on January 23, 2023

Table 2. Fragment of Students from COBAEV 55

| Nombre Completo | Nombre Corto | Correo | Teléfono | Escuela |
|-----------------|--------------|-----------------------|-------------|-----------|
| Alumno 01 | Alumno 01 | alumno_01@hotmail.com | Contacto 01 | COBAEV/55 |
| Alumno 02 | Alumno 02 | alumno_02@gmail.com | Contacto 02 | |
| Alumno 03 | Alumno 03 | alumno_03@gmail.com | Contacto 03 | |
| Alumno 04 | Alumno 04 | alumno_04@gmail.com | Contacto 04 | |
| Alumno 05 | Alumno 05 | alumno_05@gmail.com | Contacto 05 | |
| Alumno 06 | Alumno 06 | alumno_06@hotmail.com | Contacto 06 | |
| Alumno 07 | Alumno 07 | alumno_07@gmail.com | Contacto 07 | |

After this step, responses from prospective students were awaited. Those who showed no interest—either by not replying or by responding with messages such as "Thank you, I already have a registration" or "I'm not interested"—were not sent any further messages.

Once the tables were prepared with the required and corrected columns, the next step was to send the

However, students who responded with inquiries such as "How long does the program last?", "How can I register?", or "I need more information" were provided with personalized follow-ups. These students received additional details via email, were invited to a phone call for closer interaction, and were given comprehensive information about the academic program.



Figure 2. Response from WhatsApp number +52XXXXXXX9 on January 24, 2023.

Once the student's attention has been captured, a follow-up process is initiated. They are encouraged to complete their registration by providing additional program information, videos, links, and images. Additionally, support is offered for the registration process, requiring only the submission of a proof of studies and a CURP (Unique Population Registry Code). These documents are forwarded to the student services department for processing.

Continuing with the same phone number, the following image shows how the student submits the

required documents for the registration process through this platform.

Subsequently, once the registration process is completed, all students who have fulfilled this requirement are added to a group. The purpose of this group is to keep them informed about important events and dates, such as leveling courses, entrance exam dates, scholarship announcements, enrollment deadlines, and the start of classes. The following section presents the follow-up for this same student after being selected for an enrollment scholarship for the first semester.

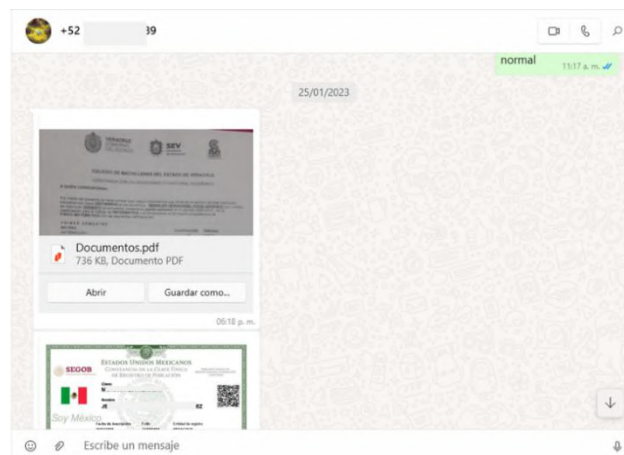


Figure 3. Submission of registration requirements from WhatsApp number +52XXXXXXX9 on January 25, 2023.

Subsequently, once the registration process has been completed, all students who meet this requirement are added to a group. The purpose of this group is to inform them about important events and dates, such as leveling courses, entrance exam dates, scholarship announcements, enrollment deadlines, and the start of classes.

The following section presents the follow-up for this same student after being selected for an enrollment scholarship for the first semester.

RESULTS AND DISCUSSION

In this research, the impact of promotional campaigns for the Computer Systems Engineering program at ITSTa has been evaluated through the use of WhatsApp messages directed at students nearing the completion of high school and who are potential new enrollees in this academic program. The implementation of this communication strategy has shown a significant effect on the response rate and the enrollment of new students.

Before the implementation of this strategy, the response rate in traditional promotional campaigns was approximately 3%. After introducing this new promotional campaign using WhatsApp as the primary medium, the rate increased significantly. This promotional method was implemented in the years 2021, 2022, and 2023, yielding positive results. Of the 61 students who enrolled in 2021, approximately 44 were recruited through this strategy. In 2022, the number rose to 52, and in 2023, 39 students were enrolled through this approach. The remaining students joined through the conventional promotional campaign, which involved visiting institutions individually or were students who had already decided where and what to study.

Figure 4 presents a fragment of the list of students who obtained their registration and enrolled in the academic program for the August 2023 – January

2024 period. This list includes the example student with the assigned control number 233S0023.

| INSTITUTO TECNOLÓGICO SUPERIOR DE TANTOYUCA | | | | | | |
|---|--------|----------|--------|-----------------------------------|----|-------------------|
| FICHAS POR CLAVE | | | | | | PAG: 1 |
| AGO23ENE24 | | | | | | SIE33200_01 |
| CARRERA: INGENIERIA EN SISTEMAS COMPUTACIONALES | | | | | | FECHA: 2024-05-28 |
| NO. | FICHA | CONTROL | NOMBRE | ESCUELA | GP | PR |
| 001 | 040001 | 233S0032 | IAN | COBAEV 55 TANTOYUCA | B | 9 |
| 002 | 040003 | 233S0027 | IAN | CETIS No.71 TANTOYUCA,VER. | A | 9 |
| 003 | 040004 | 233S0168 | O | COBAEV NO. 02, TEMPOAL,VER. | B | 7 |
| 004 | 040005 | 233S0006 | IAN | TELEBACHILLERATO EL HULE | A | 10 |
| 005 | 040006 | 233S0029 | IAN | COBAEV 55 TANTOYUCA | A | 90 |
| 006 | 040007 | 233S0005 | DO | COBAEV 55 TANTOYUCA | A | 95 |
| 007 | 040009 | 233S0251 | IR | CETIS No.71 TANTOYUCA,VER. | B | 9 |
| 008 | 040010 | 233S0010 | WIO | TEBA AHUATENO | A | 10 |
| 009 | 040011 | 233S0037 | EL | COBAEV 55 TANTOYUCA | B | 88 |
| 010 | 040012 | 233S0023 | IDO | COBAEV 55 TANTOYUCA | A | 95 |
| 011 | 040013 | 233S0008 | TIN | COBAEV 55 TANTOYUCA | A | 9 |
| 012 | 040014 | 233S0036 | VID | COBAEV 55 TANTOYUCA | B | 0 |
| 013 | 040015 | 233S0009 | OI | CETIS No.71 TANTOYUCA,VER. | A | 10 |
| 014 | 040016 | RI | EN | COBAEV 55 TANTOYUCA | B | 88 |
| 015 | 040017 | 233S0239 | SR | INSTITUTO TECNOLÓGICO SUPERIOR DE | B | 7 |
| 016 | 040018 | 233S0033 | S | COBAEV 55 TANTOYUCA | B | 72 |
| 017 | 040019 | 233S0370 | DI | PREP.LIC. BENITO JUAREZ,TANTOY | B | 8 |
| 018 | 040020 | HE | JO | CECYTEV PLATAN SANCHEZ,VER | A | 97 |
| 019 | 040021 | 233S0008 | JRO | CETIS No.71 TANTOYUCA,VER. | A | 8 |
| 020 | 040022 | 233S0015 | HEL | TELEBACHILLERATO "EL CHOTE" | A | 8 |
| 021 | 040023 | 233S0288 | OB | COBAEV NO. 02, TEMPOAL,VER. | B | 10 |
| 022 | 040024 | 233S0014 | CF | COBAEV 38,IXCATPEC,VER. | A | 8 |
| 023 | 040025 | TC | YMA | CETIS No.71 TANTOYUCA,VER. | B | 9 |
| 024 | 040026 | 233S0034 | DK | CETIS No.71 TANTOYUCA,VER. | B | 9 |
| 025 | 040027 | 233S0011 | DE | CETA No.136, SAN SEBASTIAN,VER | A | 9 |

Figure 4. Fragment of a List of Enrolled Students for the August 2023 - January 2024 Period

his substantial increase demonstrates the effectiveness of WhatsApp messages in capturing the attention of prospective students and encouraging them to choose this academic program. By using this method to follow up with potential candidates, there was a significant rise in new student enrollment over the past three years (2021, 2022, and 2023) compared to 2018, 2019, and 2020, when this strategy was not implemented. Figure 5 illustrates the increase in first-semester student enrollment.

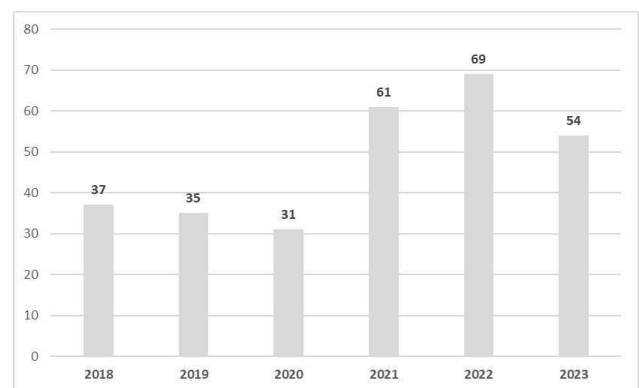


Figure 5. New Incoming Students from 2018 to 2023.

The promotional campaign implemented through WhatsApp messages not only increased the response rate but also had a direct impact on new student enrollment. The data shows that, compared to the year 2020, when 31 students enrolled, there was a 200% increase in 2021, a 222.5% increase in 2022, and a 174.1% increase in 2023.

CONCLUSIONS

Once the research was concluded, the results obtained demonstrated that: "The use of WhatsApp messages has a high degree of effectiveness and is revolutionizing the way of reaching target audiences..." Similarly, as observed in other international studies, WhatsApp is driving a significant change in the academic field of Higher Education (Martínez & Díaz, 2021).

The significant increase in new student enrollment highlights the potential of this strategy to attract more students who choose the Computer Systems Engineering program as their first option. This approach has proven to be effective, practical, and cost-efficient.

Effective: As shown in the previous figure, the approximate increase in enrollment is double compared to the years when the mass messaging strategy was not implemented.

Practical: Since the time required for sending and receiving messages is significantly less than the time spent using conventional promotional methods.

Cost-Efficient: The cost is relatively minimal, requiring only a computer and internet access for message distribution.

Figure 5 illustrates how the impact of WhatsApp messaging has significantly increased the response rate among prospective students, resulting in an average enrollment increase of 198% in new student admissions.

We can conclude by stating that adopting technologies such as mass messaging via WhatsApp as a tool for promotion and communication with prospective students represents a successful strategy. It should be considered a standard practice for all academic programs at the Instituto Tecnológico Superior de Tantoyuca.

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A brief historical overview of statistics

From its origins to the modern era

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INTRODUCTION

The perception of statistics among students at the Faculty of Medicine of Tampico "Dr. Alberto Romo Caballero" varies considerably, but some common aspects stand out. For example, many of them recognize the importance of this discipline in medicine in general, and in scientific research in particular, considering the wide range of medical information that is now available on electronic platforms, much of which is expressed in mathematical terms, probabilities, estimates, or statistical significance. Of course, I am referring to scientific information. Today, a significant theoretical and practical foundation in this field is required for adequate critical reading of scientific literature. It is recognized, therefore, that it is also a fundamental tool for evidence-based clinical decision-making.

Secondly, although students are aware of its importance, most find it difficult to understand, which generates anxiety when facing this subject, as it is part of the academic curriculum in medical school. Without a doubt, the terminology used and abstract concepts, as well as the equations, calculations, formulas, and algorithms this implies can be intimidating.

There are, of course, other contributing factors. On one hand, the teaching of this subject by professionals who are not physicians, which, while it might presuppose that as experts they would be better suited, in reality does not work as the approach, whether intended or not, is different. The experience of being a physician makes a difference. But on the other hand, and perhaps most significantly, is the lack of interested medical faculty with competencies and experience in this field.

We must say then that, in most cases, the teaching of statistics is not always aligned with practical applications in medicine, but rather tends to focus on mathematical theory. Without a doubt, the latter is important, but we must not forget, from my point of view, that students should ideally learn and understand what statistical data analysis implies, as well as their interpretation.

Therefore, what should prevail is offering a more applied approach contextualized to the medical field. It is not uncommon to hear students express their disenchantment with teaching in this overwhelming and boring discipline, which inevitably generates a negative attitude, lacking motivation and tending toward absenteeism in classrooms when it is time to take the course. It is discouraging that a high proportion of medical students finish their university career with a great deficiency in this area.

What is significant and transcendent is that when students face questions with statistical topics in the General Examination for Medical Degree (EGEL PLUS MEDI), endorsed by the National Center for Higher Education Assessment (CENEVAL), the thematic deficiencies are obvious, leading to responses that are not analytical, reflective, or based on knowledge. In the December 2023 exam administration, various items with statistical topics of practical application were presented in very concrete clinical examples. Of course, this exam also included content related to scientific research methodology, another area where there is also a lack of solid knowledge.

The difference between passing or failing this exam can, by probability, be defined by the responses to these items. For some students, this reality is confrontational and frustrating. Unfortunately, if the exam is passed, and contrary to what one might think, these deficiencies will not be addressed with any type of subsequent training by the student. They surely imagine that they will no longer need this knowledge. Similarly, although with a random approach (not included for all applicants), the National Examination for Medical Residency Aspirants (ENARM) also incorporates items with these topics. It is a reality that deficiencies cross boundaries in academic training levels, that is, it is observed that the majority of graduates who enter medical residencies also show broad gaps in knowledge in these topics. It is not uncommon that some residents show even limited competencies for searching scientific information on specific platforms, or frank ignorance of their existence.

The problem at this level is that this insufficiency will affect not only the acquisition of necessary information for their training as residents but also the development of the thesis protocol, the sole tool with which they must graduate as medical specialists. This is, of course, regardless of their interest or not in dedicating themselves to scientific research. The contradiction is that the residents themselves, like undergraduate students, recognize that mastery of the subject could make a difference in their training and medical practice. The negative perception and rejection, like everything else, has assumptions as diverse as there are residents being questioned, that is, from

complicated teaching to a frank lack of subjects related to statistics and methodology in the medical curriculum at their universities of origin. A separate point is the very particular comment that there was no one to teach these subjects. Whether true or not, the deficiencies are obvious from day one.

By virtue of all this, a teaching method is proposed, with concrete medical examples, practical application, accessible, friendly, and support with continuous guidance, all of which can make the difference. Likewise, this alternative proposes that the information above all preserves clarity, relevant content, and applicability from the first topics.

The objective is to offer students material with various topics in this discipline, but with the focus on statistical data analysis, with the ability to interpret them and with the vision that statistics is fundamental in medicine, in other words "knowing how to do," but in the medical context. Although the tools available in this field are multiple and very varied, those that I estimate are of greatest practical application will be addressed. For those interested in developing research projects, other statistical instruments may eventually be reviewed.

It would be a great achievement if the students themselves were capable of implementing and working with the statistical tools necessary for the development of their projects, and not just looking for someone to do the "statistical work," which most of the time, whoever does it, does not provide elements for understanding an effective statistical-clinical correlation. This material does not intend to replace textbooks on the subject; on the contrary, the intention is to provide information that adds to the knowledge of relevant content in this field. With this in mind and with the purpose of achieving the objective, I have considered presenting monthly installments with different topics. The content of this first installment is related to the history of statistics, an approach through time.

The journey will be brief, so to speak, since this is not an exhaustive review, simply to know the contributions of great men and impressive ancient cultures. It will be interesting to read the names of some authors that students have surely heard in their classes, as it is common for some statistical tests to bear the names of their creators.

HISTORICAL DEVELOPMENT

ORIGINS

Statistics is a scientific discipline, a branch of mathematics. Initially, the meaning was restricted to information about states. This consideration was extended to later include information of any type, and finally to include the organization, collection, and analysis and interpretation of data. Its applicability in health sciences has given rise to

the use of the term biostatistics. The historical evolution in this field has been vertiginous, with great progress through the centuries, and always with the purpose of providing methods and tools to make informed decisions and make inferences from data. Its applicability in health sciences has given rise to the use of the term biostatistics. The historical evolution in this field has been vertiginous, with great progress through the centuries, and always with the purpose of providing methods and tools to make informed decisions and make inferences from data.

Over time, methods were developed and matured, giving rise to the emergence of key concepts and techniques that today constitute the basis of modern statistical analysis. As we delve into the history of statistics, we acquire a valuable perspective of the methods and thought processes that have shaped our current understanding of data and its importance in various fields. The evolution of this discipline is a testimony to the continuous search to better understand the world around us. Without attempting to make an exhaustive summary, it is advisable to learn about some representative background and know some of the most famous exponents in this field of knowledge.

For some experts, its origins date back to ancient civilizations such as the Babylonian and Egyptian, which collected and analyzed data for commercial, tax, and astronomical purposes, among others. These early methods laid the foundations in the field of statistics. For example, the Babylonians used these strategies for agricultural production, which allowed for the implementation of tax payment and efficient resource allocation. Similarly, the Egyptians used data to plan and manage public infrastructure projects, such as irrigation systems, pyramid and temple construction projects, as well as population censuses. The first known writings on statistical methods are found in the works of ancient Persian and Arab scholars such as Al-Kindi, Al-Karayi, and Al-Jwarizmi, who made important contributions to the understanding of data analysis and interpretation through algebraic calculations and mathematical equations.

In Greece, Greek philosophers and mathematicians such as Pythagoras, Plato, and Aristotle carried out systematic studies of data and developed fundamental concepts, such as information gathering, trend analysis, and theory formulation. Pythagoras, through his famous theorem, explained how to measure and study distance and height that are of great help today for geographical analysis and map making; moreover, his contributions initiated the development of trigonometry. Archimedes and Euclid also contributed advances in mathematics and geometry. The latter demonstrated with his theorem the existence of infinite prime numbers.

In ancient Rome, statistics became an indispensable tool for maintaining control and efficiency in such an extensive and diverse empire; population censuses and mechanisms stand out, like those of other cultures, for controlling the empire's finances. These early techniques reflect the fundamental human need to understand and use data for practical purposes, laying the foundations for sophisticated statistical principles that exist today.

STATISTICS IN THE MIDDLE AGES

During the medieval period, European scholars such as the Italian Leonardo of Pisa nicknamed "Fibonacci," promoted the development of statistical methods in fields such as economics and demographics, popularized the Hindu-Arabic numerical system in Europe, and introduced in his fourth book the so-called "Square Numbers," which have found applications in probability distribution.

Other figures such as the English Franciscan friar Robert Grosseteste, who was even bishop in Lincoln, England, and the French Nicole Oresme, also bishop in Lisieux now region of Normandy and advisor to King Charles V of France, began to explore primitive statistical concepts, such as dispersion measurement and graphical representation of data.

The first made contributions to the study of light, heat, and movement, and made speculations about the creation of the universe, while the second postulated among other topics, Merton's theorem to explain the so-called average velocity, which was in favor of the earth moving and not celestial bodies. He was also the discoverer of light curvature and atmospheric refraction, although this was attributed to the English scientist Robert Hooke. Nicole Oresme is considered to have been clearer and more explicit in heliocentric considerations of the universe than Copernicus himself, an astronomer and Polish physician who was born and lived two centuries later.

ADVANCES IN THE RENAISSANCE AND THE SCIENTIFIC REVOLUTION

During the Renaissance until the epoch of the Scientific Revolution that followed it, contributions to mathematics and science in general were conducted by outstanding figures such as the Italian Galileo Galilei, who due to his interest in astronomy and using the telescope empirically confirmed the heliocentric model of the universe, which indicated that the earth and planets were the ones that orbited around the sun. He is also attributed with the formulation of the first laws about movement and dynamics, which would be culminated a century later by the Englishman Isaac Newton.

The brief reference to this great figure would not be complete if it were not noted that for criticizing Ptolemy's postulates and the geocentric vision of the universe (the opposite of heliocentric) prevailing at that time, he was found guilty of heresy in 1633, for which he was forced to live under house arrest in his villa in Tuscany, Italy, despite having abjured his heliocentric conception of the universe.

He is attributed with the hypothetical phrase "and yet it moves," which would refer to the fact that despite what was said and what he had abjured, it was the earth that moved around the sun. As an interesting added fact, it is

worth saying that in 1992, Pope John Paul II vindicated Galileo Galilei and reconciled faith with science. This historical fact was 359 years after the unjust condemnation of this great man.

For his part, the French mathematician and scientist René Descartes, father of modern rationalism and creator of the work "Metaphysical Meditations" and the "Discourse on Method," among others, made notable contributions to mathematics, medicine, analytic geometry, equation theory, mechanics, and geology. He established that one can only say that the existence of everything that exists is through everything that can be proven, hence his famous phrase "I think, therefore I am." Precisely this is the basis of methodological skepticism or Cartesian method, proposed by him. In other words, for Descartes the act of doubting is undoubtable.

In the publication at that time of the work "Liber de Ludo Aleae" (Book on Games of Chance), by the Italian Gerolamo Cardano, a detailed description of the sample spaces corresponding to the throwing of 1, 2, or 3 dice is proposed, and a first approximation to the concept of probability in terms of proportions is presented. This same author was also the first to publish complete solutions for third and fourth-degree equations. The first writings with topics related to probability calculation were proposed to solve problems posed by card and dice players. Luca Pacioli, an Italian Franciscan friar, in his work *Summa Arithmetica, Geometria, Proportioni et Proportionalita*, made reference to the so-called problem of points, through which it was intended to find the best solution for distributing money wagered by several players when the game was interrupted before finishing. It is also recognized that his contributions are the basis of modern accounting.

However, time later, the solution to the betting issue came from two French mathematicians, Blaise Pascal and Pierre de Fermat, who did not intend to reflect on the concept of chance, but only sought to apply numerical methods to analyze the alternatives posed by games of chance. In any case, in the history of science, it is considered that the Theory of Probability appeared in the second half of the 17th century, with Luca Pacioli and his writing on the "Problem of Points."

18TH CENTURY

Later in the 18th century, Jacob Bernoulli of Swiss origin made contributions to the theory of infinite series and differential equations, and like other authors contributed to probability theory, which for many authors began in that century. He stands out for his proposal to apply mathematical theory to physiological processes such as blood circulation and respiration, and conceptualized what is called binomial distribution.

Abraham de Moivre, a French mathematician, stands out for his work related to extended binomial coefficients, as well as his book "The Doctrine of Chances," which addresses topics related to normal distribution and

probability. In addition, this author made contributions to the so-called irrational or golden number, which represents an algebraic number with infinite decimal representation, that is, the calculation never reaches a final digit, although the authorship of this contribution was finally awarded to Jacques Philippe Marie Binet, also of French origin, a century later.

Thomas Bayes, British mathematician and Presbyterian minister, proposed a revolutionary approach to statistical inference, arguing that probabilities are updated as new information is obtained. His theorem, known as Bayes' Theorem, became the fundamental basis of this field. Bayesian statistics is distinguished by its ability to incorporate prior knowledge and observed evidence to make predictions and decisions. Unlike classical approaches, the Bayesian approach allows researchers to update their beliefs as new data is collected. Also in the mid-18th century began the rise of descriptive statistics in social and economic matters; however, there was opposition to the use of numerical procedures for the analysis of clinical data, as medicine was considered a discipline based on the physiology of each patient, so there could not be generalizable conclusions.

19TH CENTURY

The organization and tabulation of data was first produced in sociology, around 1927, taking into account variables and their categories. With the consolidation of probability theory in 1933, the current foundations of probabilities were established and the modern era of statistics began with inferential statistics. Similarly, in this century emerged techniques that allow the study of relationships between two variables, such as correlation and linear regression for quantitative variables and the X^2 test for qualitative variables.

In that era of continuous advances, important developments in statistics occurred with the contributions of key figures such as the German Carl Friedrich Gauss and the British Sir Francis Galton, Charles Darwin's cousin. The works of both introduced concepts such as probability distributions, regression analysis, and hypothesis testing, which are still widely used in statistical analysis today.

Carl Friedrich Gauss's contributions to statistics are significant; in 1809 he published work on the method of least squares, which is fundamental in data analysis and parameter estimation. In 1823, he introduced the famous normal distribution law to analyze astronomical data and, additionally, made important contributions in mathematics, physics, and geometry. His understanding of normal distribution and its association with the Central Limit Theorem have had a significant impact on probability theory and the modeling of natural and social phenomena. The famous normal distribution bell curve for random variables bears his name thanks to his contributions and the extensive use this author gave it in his works; however, it should be said that the normal distribution as such was initially described by mathematician Abraham de Moivre since 1733.

Sir Francis Galton's contribution to the development of linear regression was significant. His initial work on the inherited characteristics of sweet peas led to the initial conceptualization of linear regression. Through his observations, he recognized the relationship between paired variables and also developed the concept of regression to the mean. Furthermore, he generalized his work on regression to a variety of inheritance problems, which laid the foundations for the later development of multiple regression. His focus on genetics and inheritance provided the initial inspiration that led to the development of regression and the product moment correlation coefficient. This work had a significant influence on his famous proposal about correlation and regression.

Karl Pearson of English origin, who worked in Galton's laboratory, continued developing his mentor's ideas regarding rigorous mathematical treatment in multiple regression procedures. Pearson also introduced standardized methods of statistical data management, challenged the tyrannical acceptance of the normal curve as the only distribution on which to base the interpretation of statistical data, and provided mathematical statistical tools to examine the shape of empirical distribution.

He organized the first statistics course in Great Britain in 1917, and his work also included the development of goodness of fit tests. This test provided scientists with an objective tool to determine if an observed empirical distribution fit an expected theoretical distribution. Before this test, scientists had no underlying theoretical basis for their goodness of fit formulas.

Pearson's chi-square test allowed statisticians to use methods that did not depend on normal distribution, which represented a significant advance in statistical methodology. This author is recognized for creating laboratories and academic departments at the University of London, England. His prolific career and interest also led him to make significant contributions in collaboration with Raphael Weldon, also of English origin, on one hand applying statistical methods to the study of psychological differences and hereditary intelligence, and on the other hand founding the journal BIOMETRIKA in 1901 (a term used for Galton's biometric approach to inheritance topics).

During this 19th century, statistics experienced notable development and consolidation as a scientific discipline. Other notable figures included the Belgian Adolphe Quetelet, who applied the first statistical techniques to the study of social and demographic phenomena, laying the foundations of social statistics. Likewise, Florence Nightingale of Italian origin and nursing profession used statistics to improve sanitary conditions in military hospitals, becoming a pioneer in statistics applied to public health. Meanwhile, the Englishman William Sealy Gosset, known as "Student," developed Student's t-distribution, fundamental for working with numerical variables and for statistical inference. The need to use a pseudonym was due to the policies of the company where he worked,

which prohibited the publication of scientific research. His contribution was so important that the name is preserved, but from his pseudonym.

20TH CENTURY

The current era of statistics begins with decision theory and Bayesian methods, and is characterized by the establishment of multi-causal models, the search for more efficient estimation methods, the emergence of new non-parametric tests, and multivariate techniques. The advent of computers allowed this discipline to include large databases. In medicine, studies of risk factors and clinical trials begin to be conducted. The studies of this era aimed at causal relationships or probability-based predictions, within certain margins of error. The concepts of exposure, risk, association, confounding, and bias were developed with greater precision, and probability theory and numerous advanced statistical techniques were incorporated.

The British Ronald Fisher, considered one of the fathers of modern statistics, made fundamental contributions to the development of parameter estimation and statistical inference as we know it today. Fisher introduced key concepts such as the likelihood function, hypothesis testing, and analysis of variance, standing out for his line of research in genetics and for having been editor of the journal BIOMETRIKA.

As a curious and historical background in statistics and science, the rivalry with Karl Pearson stands out. The latter was known for using a more mathematical and formal approach, while Fisher had a more practical and empirical orientation focused on experimental design. The criticism between both became harsh and uncompromising; however, these controversies favored the evolution and diversification of statistical methods, given the continuous and incessant advent of scientific challenges.

Through his work, Fisher demonstrated how to use data to draw valid and generalizable conclusions about a population from a sample. His contributions in the field of statistics have been widely adopted and applied in various areas, from biology to economics and social sciences.

George Box, a prominent British statistician, made fundamental contributions to the field of experimental design. Box developed innovative techniques that allowed researchers to plan and analyze experiments more efficiently and effectively. His main contributions include factorial experimental design and the development of response surface methodology. This same author also proposed an approach known as the ARIMA (Autoregressive Integrated Moving Average) model, which allows identifying and adjusting statistical models capable of describing the behavior of complex time series. Finally, he contributed to the advancement of response surface methodology, which uses mathematical models to optimize processes and systems by identifying optimal conditions.

With the emergence of computational statistics, thanks to the appearance of the first computers, new possibilities opened up for the treatment and analysis of large data sets. Faced with these challenges, figures like John Wilder Tukey and David Cox, American and British respectively, led these developments. Tukey also focused on visualization and understanding of data through graphical and non-parametric methods, introduced innovative techniques such as the box plot and principal component analysis, which continue to be widely used today.

For his part, Cox is also recognized for his work called Cox regression analysis, a method used in survival analysis. Cox developed innovative techniques for modeling and analyzing complex data in a wide variety of fields, from medicine to economics and engineering. The Russian Andrey Kolmogorov, also in the 20th century, gained increasing importance in the field of probability theory and decision-making. Kolmogorov published in 1933 his work "Foundations of Probability Theory," where he proposed a set of axioms that define probability as a mathematical function. This collaboration marked a milestone in mathematics by providing probability theory with a solid theoretical foundation.

John Nash, the brilliant American mathematician, made fundamental contributions to the development of game theory, an interdisciplinary field that analyzes strategic interactions between rational agents. His innovative work revolutionized the way of thinking about decision-making in situations of conflict and competition. Nash developed the concept of "Nash equilibrium," a strategic solution in which each player chooses the best response to other players' strategies. This concept became a pillar of game theory and has been widely applied in fields such as economics, politics, biology, and computer science. Nash's contributions were recognized with the Nobel Prize in Economics in 1994, awarded for his work "Pioneering analysis of equilibrium processes in game theory." This work continues to be fundamental for understanding decision-making in competitive and cooperative environments.

The American Harold Hotelling generalized Student's t-test to several dimensions, developed canonical correlation analysis and principal component analysis, previously outlined by Pearson. The Polish Jerzy Neyman began to develop sampling theory to scientifically overcome the possibility of saving resources by not studying the complete population, and formulated stratified and cluster sampling designs. He gave a new approach to significance tests, strengthened the theory of confidence intervals, and created what he called Neyman-Pearson law, which establishes an optimal criterion for deciding between two hypotheses based on a statistical test. He also introduced causal analysis through the concept of treatment effect.

The Englishman Charles Spearman developed exploratory factor analysis in the field of Psychometrics, which allowed measuring unobservable abstract variables (constructs), especially intelligence. He also developed factorial experimental design and the well-known Spearman correlation coefficient.

Maurice George Kendall, also of English origin, conducted time series studies and developed what bears his name and is called: Kendall's rank correlation coefficient. The Scotsman William Gemmill Cochran developed the test called Cochran's Q test for comparing paired samples, while the Romanian Abraham Wald introduced loss and risk functions, as well as admissible decision rules, a priori distributions, Bayesian decision theory, and minimax rules for decision-making.

The Englishman Frank Yates made contributions to the theory of analysis of variance, where he developed computational methods for analyzing experiments through least squares of so-called incomplete balanced blocks, while Frank Wilcoxon of Irish origin introduced non-parametric rank sum tests for two independent samples, and the sign test for two paired samples, alternatives to Student's parametric t-test.

The American Quinn Michael McNemar proposed a test to prove the homogeneity of proportions in two correlated samples, and the Israeli Jacob Yerushalmy introduced the terms sensitivity and specificity as indicators to evaluate the inherent effectiveness of a diagnostic test. Greater computational development achieved after the 1980s allowed the application of complex iterative algorithms that can only be carried out with computer aid, such as resampling classification techniques: Bootstrap, Monte Carlo simulation, and Markov chains.

Other techniques developed are fuzzy logic, self-sufficient estimation, Bayesian models, methods based on G-estimation, data mining techniques, association rules, classification trees, and neural networks, among others. Survival calculation techniques in medicine were also introduced, and other goodness-of-fit methods for logistic regression emerged such as the Hosmer and Lemeshow test, the Score test, and finally the Cox and Snell R^2 and the application of the Receiver Operating Characteristic (ROC) curve for the evaluation of medical diagnostic methods began.

21ST CENTURY AND FUTURE CHALLENGES

In this era of big data and machine learning, statistics constitutes the backbone of algorithms and models that drive innovations in artificial intelligence, predictive analysis, and data-based decision-making; without a doubt, all this will continue to drive statistics toward new frontiers. It will also be fundamental to develop interpretable and explainable models while maintaining precision and utility. Another major challenge will be to develop statistical methods to analyze unstructured data such as text, images, and videos and create new techniques to improve the

complexity and dimensionality of current data. Without a doubt, the emphasis should be placed on ensuring the replicability of findings in different contexts, and above all, on training statisticians and data scientists.

In the field of health in general and medicine in particular, statistics will continue to play a decisive role in clinical trials, epidemiological studies, and scientific research, allowing evidence-based decision making and promoting advances in diagnoses and treatments. Through the use of statistical methods, researchers can identify patterns and correlations that help understand human behavior, social trends, and public opinion.

CONCLUSION

The enduring legacies that great men have left through time with their theoretical and methodological contributions have built the foundations of modern statistics. From its first applications in censuses and administrations in ancient civilizations, to its formalization as a scientific discipline from the 18th century, it has had a crucial role not only for knowledge but for decision making. Currently, it can be said that it is at the forefront of big data and artificial intelligence, providing indispensable tools for what is its fundamental task, data analysis. The challenges continue and without a doubt, its participation in different areas of knowledge will continue to be essential. Its history has not only maintained a rigorous approach but also an ethical one for understanding the world; these characteristics should continue to be in force.

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Life stories during the pandemic

Diagnosis of online education by the participantes: Case of the Universidad Autónoma de Tamaulipas

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INTRODUCTION

After two years of the Coronavirus Disease 2019 (COVID-19), which caused to a Public Health Emergency of International Concern, we reflect on the impact of this pandemic on the most vital aspect of the population: health, and undoubtedly on education, where the Health Sector implemented major actions to contain the spread of infections in Mexico. It is noteworthy that on January 14, 2022, the record for COVID-19 infections was broken: 44,293 cases in 24 hours. (El Sol de Tampico Newspaper, National Section, p. 5).

As is generally known, our alma mater, the Universidad Autónoma de Tamaulipas (UAT), in order to prevent the spread-transmission of this scourge, “adhered to social confinement for both general services, administrative, and academic staff, as well as students in their respective homes” (From In-Person to Virtual, 'Stories of an Experience 2020-2021,' Rosalino Amador, p. 74).

We mentioned about these experiences, “education was forced to leave the classrooms and move to the digital context; however, we continue writing, and the educational process at its various levels has not yet fully adapted to the new modality” (Olea, 2020). The experience was not simple; students and teachers, at the request of our school, and in record time, attended training courses on the use of various digital platforms.

The reality and its traditional in-person format resisted the new digital models. We were witnessing an historical change: “From the blackboard and chalk to digital platforms within the framework of the pandemic” (p. 73).

The training offered by the UAT called: Pedagogical-Virtual Scenarios (UAT, 2020), to attend students online, revealed that most of our teachers belong to a generation shaped under different socio-political-educational conditions, facing new ways of thinking, generating, transmitting, and applying knowledge in a rapidly changing global society" (Chehaibar, 2020).

This is how we start the spring 2022 period, and the conditions for the return to in-person classes were still not optimal.

The proposals from our university authorities were presented through a Hybrid Model with physical presence in the classrooms.

Teaching styles were adapted to the new times of education; new communication practices were established, not only between teachers and students but also across the institution (UAT) with students and parents.

The training courses continued on schedule, but it is worth emphasizing that our teaching work, in most cases, is more about teaching than about learning approach; more about remote education than virtual or hybrid. Hence, both professors and students were attentive to the academic programs issued by the H. Rector of our institution. Thus, in this context, we continued carrying out the academic functions outlined in the Academic and Student Staff Regulations, respectively.

However, once the pandemic was declared over, it was imperative to understand what had happened during that period. It was urgent to take stock of the damages and the strengths. News arrived about the death of some students and teachers, as well as those in recovery; in addition to the strategies of our university's top authorities to carry out the school terms. This effort from UAT teachers and administrators, who hurried, after the contingency, to determine the most suitable options for resuming the course we needed to take.

In this context, and at the invitation of Dr. Wilberto Sánchez Márquez, the members of the Disciplinary Group: Education, Health, and Community, GD-UAT-128, from the School of Medicine of Tampico, 'Dr. Alberto Romo Caballero,' gathered to conduct a situational diagnosis among the teaching and student community of the southern region of the university's main campus. The results were later shared with the community through the literary work *Life Stories during the Pandemic: Diagnosis of Online Education by the Stakeholders*. Case of the Universidad Autónoma de Tamaulipas.

This book, published by Porrúa Hermanos and Company, S.A. de C.V., from Mexico City, First Edition, 2022, was delivered to our dean, Dr. Raúl de León Escobedo, and to the H. Rector of our university for the relevant academic purposes, with the effort and resources of the Disciplinary Group.

The coordination of the work was led by the following full-time faculty members of UAT:

Wilberto Sánchez Márquez, Gabriela Clemente Sánchez, Rosalino Amador Alonso, Leticia Caloca Carrasco, Jorge Pérez Ramírez, Brian González Pérez, Ricardo Salas Flores, Verónica Olvera Mendoza, and Sergio Reyes Cruz (+).

As of today, as we approach the 75th anniversary, which will be in September 2025, feeling an immeasurable debt to our alma mater for the academic and life formation it provided us, we want to pay tribute to it on this anniversary by telling a story that should never be repeated. Authoritative sources indicate that more than 800,000 people should not have died due to the lack of care from those who were entrusted with the responsibility of safeguarding our health; that there was significant and hardly recoverable loss in education levels, among other aspects of national life, and the lack of commitment from our government system.

Today, we are no better. This day, I open the pages of a morning newspaper with local and national news, and in the face of the pain, sorrow, and helplessness due to the actions of the majority blocks in the Congress of the Union, parliamentary groups turned into skilled political strategists, I read: 'In Tamaulipas and Veracruz, Alarm as dengue cases increase; More than 10,000 cases of pharyngitis and tonsillitis recorded in the area; Specialty Hospital in service; Call to the federation, etc., etc.....!'. El Sol de Tampico, Sunday, September 8, 2024. God willing, we will not have to experience another pandemic. However, we find ourselves in a secular institution, Presentation (Work cited).

“The school, conceived as a physical space, closed and moved to homes due to COVID-19; as a result, educational systems had to develop, overnight, a massive offer of distance learning and emergency remote teaching. The reality is that there are few comparable experiences in the last ten years to the complete closure of educational institutions caused by a health emergency" (Jara, 2020).”

Teachers have been forced to flexibilize their way of teaching and communicating with students. The university in the southern campus was no exception.

“On a macro level, a new dynamic was created, in which parents and other family members had to take on the role of supporting the students' learning." Technology became the central instrument”.

“Students who had the support of their families and a digital foundation, at least during the period in which they interacted with them, made better use of the resources available to them”

“In this sense, life history, as qualitative research, seeks to uncover the relationship between reasoning, the daily negotiation between fantasy and reality, between creation and acceptance, common sense, and the explanations and reconstructions that each individual makes in order to live and survive daily" (Ruiz Olabuénaga, 2012).

In our book: “The descriptions presented were obtained from the information collected based on what occurred and was observed in the interactions with university students from the schools in the southern campus, during the period from October to December 2020.' From the number of students enrolled in the various schools who met the requirements, a sample of six hundred seventy-two students was collected, regardless of gender, age, and who wished to participate in the study with prior informed consent, prior interaction, and a survey determined by the researchers.

CHAPTER I. SOCIAL INTERACTION

Dr. Wilberto Sánchez Márquez.

Dra. Gabriela Clemente Martínez

“Being in contact with the students during the period of distance learning due to health circumstances, the conversations with them were the support to learn more about how they managed their academic life during this forced confinement, in a context where the dividing line between school duties and their personal life was, undoubtedly, very thin as they were at home, not in the classrooms, a situation that has impacted their development. This last point is one of the assumptions of the present chapter”

“The significant responses that almost unanimously revealed the students were that they experienced both positive and negative aspects from their family members, which will be detailed below; that is, their relatives were empathetic and kind”.

“Finally, a definition of social interaction was provided by a student and was crucial to closing the positive experiences lived during the confinement. Here it is shared: 'Social interaction is enjoying and making the most of your family, but that's not always an option, because at least in my case, I didn't even have time to be with them during meal hours due to classes and the excess of work”.

“In the words of the students, some of their most relevant evaluations highlight that “sometimes you need more space at home to concentrate; the environment is not like the library, which was a good place to study”.

“The authors have considered as significant those neutral expressions in which the thoughts and feelings of the students remained in a middle point”.

CHAPTER II. PSYCHOLOGICAL FACTORS

Rosalino Amador Alonso.

Leticia Caloca Carrasco.

“The situation of confinement and isolation in which we found ourselves, which has persisted since the declaration of the global state of emergency caused by COVID-19, forced everyone to take appropriate actions to continue with active life. In the education sector, the teaching process was shifted to a distance context”.

“There were some significant modifications in the lives of the actors: administrators, teachers, students, among others”

“Changes from a psychological point of view that, in this chapter, we believe are important to discuss, specifically in the case of students from the Universidad Autónoma de Tamaulipas, southern campus”.

“Part of our expectations for finding insights by observing and interacting with the students were that anxiety, worry, or fear were the most common emotions they presented in a scenario like the one they are experiencing, and these are products of a defense mechanism against unknown and potentially dangerous circumstances”.

However, at some point in the introduction to the aforementioned chapter of collaboration, it was revealed that other effects of confinement they presented were: anger, loneliness, boredom, frustration, anger, sadness, hopelessness, among others.

Now, it was not only the negative aspects that prevailed, but positive emotions were also identified in the young students, such as gratitude, joy, solidarity, and empathy. In addition, students continuously expressed affection for their family members and peers, as well as staying motivated and spreading that spirit to others from a distance.

A deep knowledge remains for us from what we concluded based on the opinions of our students, to whom we expressed with much responsibility and appreciation that, moving forward, we should focus on the most positive versions of what happens in our environment, especially in situations of public health emergencies.

CHAPTER III. HEALTH

Jorge Pérez Ramírez.

Brian González Pérez.

Ricardo Salas Flores.

“On December 31, 2019, the Health Commission and the Municipal Health Commission of Wuhan reported a group of cases of pneumonia of unknown etiology, whose common source of exposure was the seafood market in the city of Wuhan, Hubei province, China. Subsequent investigations identified a new coronavirus as the causative agent of the respiratory symptoms in these cases. The now-recognized virus is called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).”

“The Government of Mexico, in coordination with the Ministry of Health, has implemented measures to prevent and control the epidemic”.

“Starting March 23, The “Jornada Nacional” announced about the extension of the student vacation period and the healthy distance, which included social distancing, frequent handwashing, respiratory etiquette for distance greetings, the 'Stay at Home' campaign, and isolation at home for suspected or confirmed COVID-19 cases”.

These measures affected the university population.

Confinement at home and the closure of sports facilities may have affected physical activity and contributed to sedentary behavior in university students, as recreational interests in screen-based activities increased, which worsened with the implementation of online classes' (WHO, 2021).

“Few studies in Mexico have analyzed the impact of the COVID-19 pandemic on university students' physical activity in this specific population. Therefore, the objective of this study is to understand the narratives and opinions regarding changes in physical activity and barriers to engaging in it among university students at the

School of Medicine 'Dr. Alberto Romo Caballero,' in the city of Tampico, Tamaulipas, during the health contingency”.

“The results of the observations showed that more than half of the students who were part of the sample dedicated some time to various physical activities and exercise; however, others denied doing so. Among the various reasons they provided for being unable to engage in physical exercise, they stated:

“The time spent in online classes and the poor quality of their phone’s internet forced them to search for a place to connect”.

“Time availability is something that needs to be organized," "I did some exercise on some days, but not consistently”.

The students responded to the survey and showed that 57% (n=384) did not improve their physical condition, due to various opinions they expressed, such as the following: 'Sitting for so long led to lower back pain”.

“Well, this affected me. Because most of the day is filled with assignments, and sometimes I don't have time to review and consolidate my knowledge”.

For the students, adhering to these preventive measures meant experiencing many changes, such as distance learning, confinement at home, reduced mobility both on foot and by vehicle, interruption of access to recreational and physical activity facilities, and interruptions in their access to places where they used to eat.

CONCLUSIONS:

“Neglecting the mental health of university students would lead to harmful long-term effects, which will not only affect their quality of life but also their overall performance”.

CHAPTER IV. ECONOMIC FACTORS

Verónica Olvera Mendoza.

“COVID-19 had a wide spread and caused a pandemic in 2020, with profound social, psychological, and economic impacts on the population and institutions”.

“The population is the primary focus of this study, as due to the recent acquisition of knowledge about the disease, isolation of suspected patients is required; this forces the granting of sick leave to workers showing symptoms, awaiting confirmation test results, which causes economic losses both personally and within the family”

“By this time, as far as we know, there have been no published analyses on the financial impact of COVID-19 on affected families, particularly how it affects university students and their education." Thus, the objective of this study was to understand the narratives and opinions of university students at the School of Medicine 'Dr. Alberto Romo Caballero,' in the city of Tampico, Tamaulipas, during the health contingency”

“Due to the forced isolation from the health emergency, thousands of real classrooms and educational spaces were replaced by places in homes that were once zones for rest or social interaction. This disruption has caused confusion, work is done wherever is possible or where there is space, depending on the dimensions and structure of the housing. This is further compounded by asynchrony, which has been overused because work, rest, eating, and family interaction schedules were lost. We can also add that distractions from work or academic tasks are now easily accessible (Jesús, 2020)”.

“The economy is an important aspect within family dynamics, as it affects all members; it allows or prevents many activities from taking place (Álvarez, 2020).”

Professor Olvera highlights the areas impacted by the pandemic on the economy and provides a detailed explanation of the cases.

- Economic impact on studies.
- COVID-19 scholarship request to continue studying.
- Need to work to finance studies.
- Family economic provider stopped working, affecting economic development.
- Economic factor impacting regular access to the educational platform due to lack of internet, among others.

Conclusions.

“In addition, the economic consequences of the pandemic exacerbated disparities in medical education”

“Without proper intervention, barriers to online learning would not only affect the education and training of future doctors”, “but even the provision of healthcare services in the country could be disrupted”.

CHAPTER V. INFRASTRUCTURE.

Sergio Reyes Cruz. (+).

“Currently, technological advancements have permeated all spheres of society, and education has not been the exception. This scenario is reflected in the adoption of new teaching models, the redefinition of roles in education, and the way technology is implemented to effectively support student learning at various educational levels”.

The world benefits from technology every day, which brings with it a series of advantages, especially in the school environment, where it has revolutionized the way of teaching and learning. Today, more than ever, we need it to access education during the pandemic, as students are unable to attend educational institutions due to quarantine. This causes both students and teachers to seek ways to overcome the digital divide to access quality and meaningful education; the teacher is recognized for, despite being a technological immigrant, training to turn technology into a real tool for teaching.

“The way of teaching has positively changed due to the new coronavirus”.

“Information and Communication Technologies (ICT) have entered classrooms at a rapid pace and now demand to be used, as the digital era has undergone many transformations, both technologically and educationally. Pedagogical models have changed, prompting teachers to modify their working methodologies and use technology to improve educational processes with innovative resources”.

“For students, the use of digital technologies is more than just a technological resource, because through the implementation of ICT, it promotes the development of competencies and skills, such as the construction and appropriation of knowledge and optimal academic development”.

“Classes from home, combined with the problems caused by quarantine, meant stress for all the actors in the educational system (Gagliardi, 2020)”.

“In a student population with difficulties accessing the internet or with few personal devices to connect to the web, the option of working synchronously can become a problem (Gagliardi, 2020)”.

“Then, the questions arise: Can all our students meet this requirement? What happens if someone else in the household needs to use that device to work?”

“E-learning is a pipe dream, an alternative for those who have quality devices with internet access at home. Unfortunately, too many students do not have this resource, nor the material, environmental, and spatial conditions to benefit from this option (Murillo, 2020)”. “Another important aspect is to know whether the student had the appropriate physical space that allowed them to be focused and enhance their academic work”.

“The following factors are relevant to achieving a good study environment”:

- Set a study space.
- Appropriate furniture and organization.
- Good ventilation and correct temperature.
- Adequate lighting.
- Free from noise and distractions.

“Based on the technological infrastructure available at the educational institution, it is necessary to develop a strategic plan for Technology and Information Systems to implement a policy for the progressive use of ICT in the classroom, with rules, access guidelines, and scientific information sources”.

The coordination of the Disciplinary Group: Education, Health, and Community from the Faculty of Medicine of Tampico 'Dr. Alberto Romo Caballero' has decided to reissue, in a synthetic form, this work. We take this opportunity to inform you that there is a cultural collection of more works from our researchers available for your access.

“In Mexico, no studies have been conducted to understand the life stories of university students that analyze the repercussions of the COVID-19 pandemic on their academic progress and their day-to-day experiences in this specific population. Therefore, the objective set from the beginning by the researchers as the trigger for this study—i.e., to learn the stories and opinions expressed by university students during the health emergency—has been addressed in the context of the six hundred seventy-two students, to whom we take this opportunity to express our gratitude. Without their testimony, it would not have been possible to have a snapshot of what was happening on the other side of the screens of their computers or mobile devices through the various platforms offered by the Universidad Autónoma de Tamaulipas”.



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