

# REVISTA **CIE**

**REVISTA DE INVESTIGACIÓN EDUCATIVA**  
VOL.1 NO.2

**Innovación, Salud y Educación en el Contexto Actual**

Aniversario  
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1950-2025

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Revista CIE. Año 2025, Volumen 1, Número 2, julio-diciembre. Publicación semestral editada por la Facultad de Medicina de Tampico de la Universidad Autónoma de Tamaulipas, a través del Centro de Investigación Educativa, Centro Universitario Sur, Tampico, Tamaulipas, México, CP. 89337. Tels. (833) 2 41 20 00, ext. 3315. Página web: <https://revistacie.uat.edu.mx/> y correo electrónico: [revistacie@uat.edu.mx](mailto:revistacie@uat.edu.mx). Editor responsable: Dra. Miriam Janet Cervantes López. Reserva de Derechos Uso Exclusivo: 04-2024-120213161900-102, ISSN electrónico: 3061-8657, ambos otorgados por el Instituto Nacional del Derecho de Autor; Responsable de la última actualización de este número: Dra. Miriam Janet Cervantes López. Fecha de la última modificación: 22 de septiembre de 2025.

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## Innovation, Health and Education in the Current Context

We are pleased to present the second edition of the CIE Journal of Educational Research, from the School of Medicine of Tampico “Dr. Alberto Romo Caballero,” of the Universidad Autónoma de Tamaulipas. This volume confirms the purpose of this magazine as an academic space for the dissemination of studies, experiences and reflections that address contemporary challenges in education and health, two fields intimately related to social well-being.

Current reality demands interdisciplinary responses that integrate biomedical research, technological innovation, and pedagogical analysis. The complexity of educational and health scenarios is not limited to the transmission of knowledge, but rather involves the development of ethical, technological, social and communicational skills that allow the positive transformation of the lives of communities. In this regard, scientific research becomes the basis for the design, evaluation and improvement of educational practices in the comprehensive care of society.

In this issue, we have selected articles that reflect the thematic and methodological diversity of academic projects, which converge on the same goal: bring solutions and reflections to the current challenges of society. In the field of health, the analysis of relevant clinical conditions that significantly affect vulnerable populations is addressed, highlighting the need to strengthen biomedical research as support for public policies and more effective medical practices. In the field of technology, innovative proposals are presented, ranging from the design of telemedicine systems focused on improving access to healthcare in rural communities, to the development of virtual applications with artificial intelligence that look to promote learning processes in children with specific educational needs.

In the field of education, the included studies explore the impact of virtual learning environments as tools to support college instruction, as well as the influence of family relationships on the academic performance of teenagers, emphasizing the role of social and emotional factors in the comprehensive training of students. Collectively, these papers show that research, by integrating health, education and technology, becomes a fundamental axis for understanding the complexity of contemporary reality by generating strategies that contribute to the well-being and development of the community.

This volume stands as a testament to academic effort and commitment to excellence in research, reaffirming that only through interdisciplinary work can current challenges be addressed. In this sense, the preparation of this number has been possible thanks to the active collaboration of teachers, researchers and students, whose dedication and commitment have contributed to the consolidation of this editorial project. To them, to our academic community, as well as to distinguished colleagues from other institutions, we extend our sincere thanks, as their valuable reviews and contributions have significantly enriched the content presented here.

Looking ahead, the CIE Journal of Educational Research will continue to be a space for meeting and reflecting, inviting the academic community to continue participating by means of publishing their research, the critical review of works, and proposing new lines of study that respond to emerging challenges in health and education. Finally, we reiterate our commitment to academic excellence, innovation, and strengthening educational and scientific research, trusting that this second volume will be a reference that inspires new initiatives to help society.

Sincerely

**Dra. Miriam Janet Cervantes López**

**Editor-in-Chief**



## Development of a Telemedicine system for rural areas

### Desarrollo de un sistema de Telemedicina para zonas rurales

Guadalupe Esmeralda Rivera García, Juan Carlos Ramírez Vázquez, Ángel Eduardo del Ángel Hernández, José Angel Hernández Santiago\*

#### Abstract

Telemedicine systems are a strategy to provide accessible, high-quality healthcare to communities that face significant barriers to accessing appropriate healthcare services. Through the integration of information and communication technologies (ICT), these initiatives enable residents of remote and disadvantaged areas to access medical consultations, diagnoses and disease monitoring without the need for prolonged travel. This research focuses on the problem of limited access to specialized health services in marginalized regions of northern Veracruz and southern Tamaulipas. In response to these challenges, the development of a telemedicine platform is proposed with the aim of facilitating medical consultations with specialists. The methodology used involves the identification of system requirements, culminating in the creation of a telemedicine web platform that allows remote medical consultations. In conclusion, telemedicine emerges as an innovative opportunity to improve medical care in underserved areas, offering practical and sustainable solutions to overcome existing barriers, and potentially transform the health landscape in these communities.

**Keywords:** telemedicine; consultations; distance; medicine; telemedicine platform

#### Resumen

Los sistemas de telemedicina constituyen una estrategia para proporcionar atención médica accesible y de alta calidad a comunidades que enfrentan obstáculos significativos para acceder a servicios médicos adecuados. A través de la integración de tecnologías de la información y comunicación (TIC), estas iniciativas posibilitan que los residentes de áreas remotas y desfavorecidas accedan a consultas médicas, diagnósticos y seguimiento de enfermedades sin necesidad de desplazamientos prolongados. La presente investigación se centra en la problemática del acceso limitado a servicios de salud especializados en regiones marginadas del norte de Veracruz y del sur de Tamaulipas. Como respuesta a estos desafíos, se propone el desarrollo de una plataforma de telemedicina con el objetivo de facilitar consultas médicas con especialistas. La metodología empleada implica la identificación de los requisitos del sistema, culminando en la creación de una plataforma web de telemedicina que permite realizar consultas médicas a distancia. En conclusión, la telemedicina emerge como una oportunidad innovadora para mejorar la atención médica en zonas marginadas, ofreciendo soluciones prácticas y sostenibles para superar las barreras existentes, y potencialmente transformar el panorama de la salud en estas comunidades.

**Palabras clave:** telemedicina; consultas; distancia; medicina; plataforma de telemedicina

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**Fecha de recepción:** 21/agosto/2024 | **Fecha de aceptación:** 03/septiembre/2024 | **Fecha de publicación:** 22/septiembre/2025

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### INTRODUCTION

Telemedicine has established itself as an innovative and revolutionary solution in the field of health care, providing a route to carry medical services to the most neglected and marginalized communities (Mesa & Pérez 2020). In an increasingly digital world, telemedicine uses information and communication technologies (ITCs) to offer remote medical care (Castillo et al., 2022), overcoming the geographical and logistics limitations that traditionally have obstructed access to health in remote and disadvantaged regions. This approach not only improves the accessibility and quality of health care but also has the potential to transform the lives of millions of people who reside in marginalized areas (Saiso et al., 2021).

Marginalized regions, often marked by geographic isolation, lack of infrastructure and shortage of medical resources, face major challenges in the delivery of health services (Santiago,2024). These challenges include the shortage of trained medical personnel, poor infrastructure, and restrictions on the access to medication and medical technologies, resulting in an inadequate health care that undermines the health and well-being of vulnerable populations (Vázquez et al., 2020). In many cases, health centers are hours away, and the lack of appropriate transportation prevents patients from receiving regular and timely health care. Also, unfavorable socio-economic conditions worsen this situation, because many people cannot pay the expenses associated with travel or medical treatment (Sanz & Oliva, 2021).

In this context, telemedicine emerges as an essential tool to close the gap in health care, offering sustainable and accessible solutions. Through digital platforms and mobile devices, telemedicine provides a way to overcome these barriers (Aizenberg, 2023), offering specialized and uninterrupted medical care to those that need it most. This has a significant impact on these regions by allowing remote medical appointments, reducing the need for expensive and often prohibiting trips to receive attention, which is particularly relevant in rural and remote areas where health centers could be far and away (Vanegas, 2020). Also, telemedicine eases the follow up and management of chronic diseases, allowing patients to receive constant monitoring and orientation without leaving their communities, which is crucial for the management of conditions such as diabetes, hypertension, and cardiac diseases, which require regular monitoring and treatment adjustments (López et al., 2021).

Telemedicine covers a wide range of services, from online medical consultation and remote patient monitoring, to continuing education for health care professionals. Through digital platforms, patients can contact specialists and medicine doctors without the need to travel, which is beneficial for those with reduced mobility or chronic conditions that require constant supervision (Bustamante, 2023). Connected medical devices, like blood pressure monitors and glucose meters, allow real time transmission of vital data to health care providers, facilitating continuous monitoring and effective

disease management. These advances not only improve the quality of life of patients but also optimize the use of health care resources and the associated costs from the medical attention (Gómez, Salas & Fernández, 2023).

The successful implementation of telemedicine systems in marginalized areas requires careful planning and close collaboration between various actors, including the government, non-governmental organizations, health care providers and the private sector (López et al., 2023). In addition, it has the potential to improve the education and training of local health care professionals. Through webinars, online conferences and remote training programs, doctors and nurses can access up-to-date information to develop their skills without the need to travel to urban centers, thus contributing to strengthening local capacities to address health challenges and improve the quality of care provided to the community (Castaño, García & Medina, 2022).

However, it is essential to assess the specific needs of the community and design a system that is accessible and easy to use for patients and health care professionals. Technological infrastructure, such as internet connectivity and availability of adequate devices, is a critical component that must be developed and maintained (Barbosa & Sanjuan, 2023). In addition, the education and training of health care providers in the use of telemedicine tools is essential to ensure a successful and sustainable implementation (Rodríguez et al., 2023).

The development of telemedicine also poses several challenges, especially in terms of privacy and security of the patient's personal information (Pico & Aparicio, 2020). It is crucial that government initiatives and collaboration with non-governmental organizations and the private sector develop adequate and accessible technological infrastructures. Furthermore, it is essential to consider the privacy and security of medical data, as well as the protection of patient information against unauthorized access (Quispe, 2021).

Local regulations and laws must be enforced rigorously to protect the patient's rights and maintain confidence in the health care system (Gianfelici, 2022). Also, digital literacy in communities needs to be addressed, ensuring that patients and their families learn how to use telemedicine platforms and feel comfortable doing so. Internet connectivity and the availability of suitable devices are also critical factors that must be addressed to ensure the effectiveness of these systems (Zambrano et al., 2023).

Education and awareness emerge as crucial elements in the adoption of telemedicine, highlighting the importance of the patient's understanding of the benefits of this modality and how it can be integrated into their daily lives. Awareness campaigns and community education programs have the potential to overcome cultural and social barriers that could hinder the acceptance of new health technologies. Testimonials from other patients and endorsements from community leaders can act as powerful catalysts

for change, promoting a favorable attitude toward telemedicine (Fernandez, 2022).

Globally, telemedicine has proven its effectiveness in a variety of circumstances, from health crisis to chronic disease management. The COVID-19 pandemic highlighted the relevance of telemedicine by enabling the continuity of care in times of physical constraints. This experience has accelerated the adoption of digital health technologies and underscored the need to invest in robust and accessible telemedicine systems. For the marginalized areas, this transition may represent an unprecedented opportunity to improve the health and well-being of their residents (Carbonel et al., 2024).

This study presents the design and development of a telemedicine system, conceived through interfaces that facilitate its use by physicians, swiftly providing the resources and tools they might need.

### **METHODS, TECHNIQUES, AND INSTRUMENTS**

For the design of the platform interfaces, the programming language was HTML, while JavaScript and PHP were used for the internal operation of the system and its integration with real-time video call services, allowing physicians to visualize and examine the patient in real time.

Regarding the telemedicine system requirements, provided by the physicians from the Facultad de Medicina of the Universidad Autónoma de

Tamaulipas, the following aspects are included: the management of the patient medical records to access data such as X-rays and laboratory results, the possibility of scheduling appointments with other physicians from different clinics through the platform, the management of patients at a clinical level to restrict their access only to authorized physicians, and the integration of real time video calls.

The telemedicine system represents a solution to address the problem of difficult access to specialized health services in certain marginalized areas of northern Veracruz and southern Tamaulipas. Four main actors are involved in the operation of the system: the system administrator, clinic managers, social service students and medical interns, as well as specialists. To access the system, you must enter the link [www.telemesys.net](http://www.telemesys.net) and use the access credentials provided, allowing you to start working on the platform.

The telemedicine system, through video calls, promises to be highly beneficial, easing the consultation between a specialist doctor, the clinic administrator and a social service student who interacts directly with the patient. This will make it possible to track medical records including data such as X-rays and laboratory results, as well as to schedule appointments with other physicians in different clinics. For the patients of rural clinics, the chance to receive prescriptions issued by specialists will be opened and will be authorized and signed by the clinic administrator. The availability of medical

appointments with specialists through telemedicine can have a decisive impact on the preservation of lives.

The system is structured in four main sections: Appointments, Patients, Clinics and Doctors in the Clinics section, it is possible to create new clinics with basic data such as the person in charge, address and working hours. In the Doctors section, the registration of new physicians is allowed, requesting general information from both the head of the clinic and the undergraduate students.

In the Patients section, individuals coming from the clinics can be added, identified by their CURP (Unique Population Registry Code) to avoid duplications, and their clinical record must be completed. Once this process is completed, the patient's appointment history, clinical record, and a specific space for uploading laboratory files can be accessed. Under Appointments, there are four subdivisions: a record of previous appointments, the possibility of scheduling new appointments and a space for sending invitations to appointments with other doctors.

When creating a new appointment, the clinic administrator or the undergraduate medicine student can invite a specialist from a list, who must confirm or decline the invitation. Once the appointment is confirmed, it will appear in the upcoming appointments section. The specialist will have access to the patient's contact information, medical records, and clinical documents. Also, minutes before the

appointment, the undergraduate medicine student must record general patient data, such as temperature, height, weight, blood pressure, heart rate and body mass index, which must be entered into the system to enable the video call.

## RESULTS AND DISCUSSION

Once the essential elements of the system have been taken into account, the process of designing its visual structure begins, using a web design tool known as Figma. This platform, available for free, allows us to create user interfaces, as illustrated in the figure 1.

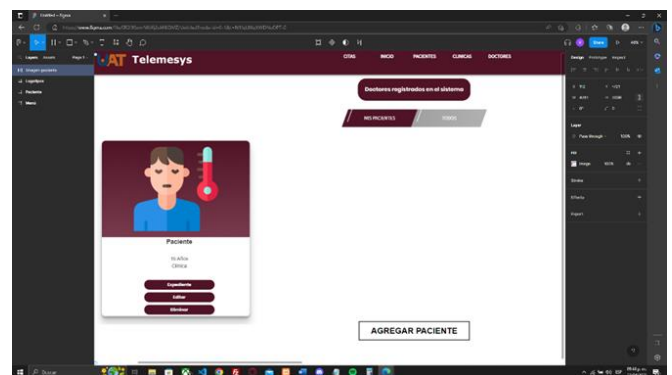


Figure 1. Interface design by the Figma platform

Once the interface has been designed, we move on to the actual implementation of the platform, which involves coding both these interfaces and their respective functionalities. For this purpose, the programming languages used are PHP, JavaScript y HTML, addressing the individual requirements in each section of the system. Initially, the development of a system of clinics within the platform has been launched. The purpose of this function is to manage and categorize patients according to the health center

in which they are affiliated, thus allowing better organization by areas for the students. Figure 2.



Figure 2. Clinics sections in the platform

Following the segmentation of the system into clinic units, patient administration is simplified, thus incorporating a patient registration form that includes clinical questioning. This form will then make it easier for doctors to create clinical records, which will be generated and stored on the platform. Once registered, these records cannot be modified or altered, guaranteeing the preservation of the patient's dignity, and ensuring ethical integrity in all procedures performed. Figure 3.

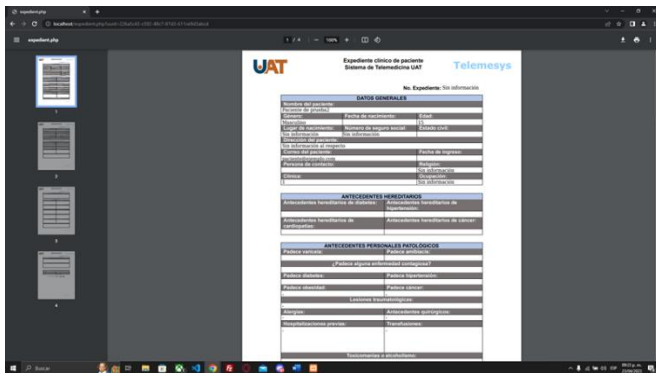


Figure 3. Clinical record format generated by the system

Appointment management aims to facilitate the physician's connection with specialists from different clinics and medical areas. Through the

system, the doctor can request a medical appointment, which must be previously confirmed by the specialist. The latter receives an invitation within the platform, which can accept or decline according to their availability and professional criteria.



Figure 3. Medical appointments management section

The teleconsultation is performed through a video call generated within the platform itself, which, when the consultation is initiated, triggers a conference in the Jitsi Meet API. This API provides secure and encrypted videoconferencing with the DTLS-SRTP security protocol, ensuring privacy and ethics in the medical process. In addition, the doctor who is present with the patient has to enter preliminary patient data, such as symptoms, temperature, weight, height, among others. This data not only streamlines the process for the specialist doctor, but is also permanently recorded on the platform, forming part of the patient's clinical history, which is immutable and securely stored. Figure 5.

At the end of the teleconsultation, the physician can generate a prescription directly through the system. This prescription includes information such as the name of the doctor, his/her medical professional license number, home institution, as well as the

details of the treatment prescribed, in accordance with the legal requirements demanded by Mexican legislation for this type of documents.

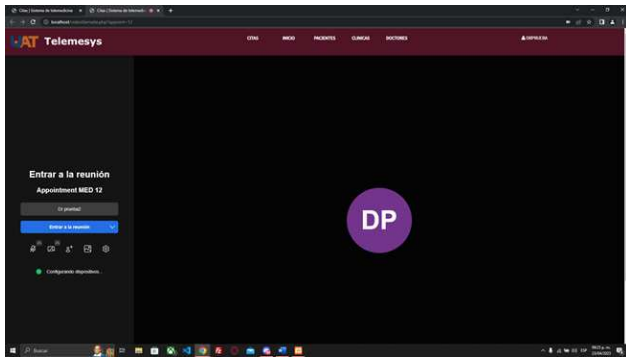


Figure 5. Video call generated on the platform for patient care

Finally, there is a test program is scheduled to start soon, in order to test the functionality of the system, implementing it in several health care centers in the city of Tampico, Tamaulipas, Mexico. This project will be carried out in collaboration with students of the Surgeon Physician Degree from the Universidad Autónoma de Tamaulipas that are currently doing their social service internships. The implementation of the platform aims to provide families in the region with access to consultations with medical specialists without the need to travel to other cities or hospitals, allowing them to attend exclusively to their nearest health center.

One of the main benefits of telemedicine in marginalized areas lies in its ability to overcome geographic limitations and improved access to medical care. A study by Guerra (2018) explored how telemedicine has made remote medical consultations more accessible in rural areas of the United States,

thereby reducing the need for patients to make long trips to access specialty care. In a similar case, Shewamene et al. (2021) conducted research to assess access and utilization of health services through telemedicine in remote areas of sub-Saharan Africa. The results indicated that the use of telemedicine significantly increased medical care, especially among vulnerable groups such as pregnant woman and children.

In addition, telemedicine can improve early detection and management of chronic diseases in these communities. A study by Huaiquián, Espinoza & Ríos (2022) highlighted how telemedicine has enabled a more effective monitoring of patients with chronic diseases such as diabetes and hypertension, which facilitates early interventions and reduces associated complications. Williams & Shang (2024) examined the effectiveness of a telemedicine system in the management of chronic diseases such as diabetes and hypertension in a rural community, obtaining results that showed a significant improvement in the control of blood glucose and blood pressure levels, as well as increased adherence to treatment among participants.

On the other side, a longitudinal study by Pont et al. (2021) investigated the impact of telemedicine on early detection and prevention of disease in an Indigenous community in South America. The results revealed a significant improvement in the early detection of chronic diseases and an increase in participation in health promotion and preventive care activities.

Even though telemedicine has significant benefits, its application in marginalized areas faces several challenges. A World Health Organization (WHO) report (WHO,2020) identified the lack of technological infrastructure and a shortage of trained medical personnel such as the main obstacles to the adoption of telemedicine in developing countries. A case study by Ziegler et al. (2020) identified technological and infrastructural challenges affecting telemedicine implementation in rural areas of North America, including limited internet connectivity and lack of technical training among health care providers.

In addition, privacy and security of patient data are important concerns in telemedicine environments. Fernandez (2020), in his research, highlighted the need to address concerns about the confidentiality of medical information transmitted through electronic channels, especially in regions where data protection regulations are less rigorous. In a similar context, Reino (2023) conducted an analysis of the legal and ethical implications of telemedicine use in rural areas of Latin America, identifying concerns about health data privacy, informed consent, and medical liability. This highlights the importance of establishing clear regulatory frameworks and data security policies..

### CONCLUSIONS

In front of the social challenges Mexico faces, telemedicine emerges as one of the most viable alternatives to address and counteract the difficulties in accessing specialized medical services in

marginalized areas. The development of this platform presents itself as a totally feasible option, with multiple doctors willing to provide medical care through remote consultations, while being assisted in person by colleagues or medicine doctors in their social service internship. The application of this platform could contribute to counteract the worrying statistics related to medical accessibility in Mexico, and with it, potentially save human lives.

The development of implementation strategies and infrastructure for the use of the platform presents itself as a challenge but represents a more viable alternative to the various obstacles that prevent society from going to specialized medical units. One of the main challenges faced by the platform lies in the constant need for the presence of medical students or medicine doctors in their social service internship to carry out an adequate examination of the patient and evaluate their symptomatology, which leads to the need of employing human resources in the areas where the platform is planned to be used, which is in itself a challenge for implementation. Another crucial aspect to consider is the importance of providing training to the personnel who will use the platform, in order to guarantee its correct use and optimize time. However, the intuitive designed interfaces make the website easy to understand, doctors can easily grasp the functionality of each section of the system.

The telemedicine system represents a revolutionary opportunity to improve medical care in marginalized

areas, offering practical and sustainable solutions to overcome existing barriers. By leveraging modern technologies and fostering collaboration among diverse actors, it is possible to transform the health landscape in these communities, ensuring that all individuals, regardless of location, have access to quality medical services.

Successful implementation of a telemedicine system requires a comprehensive strategy that considers local needs, technology infrastructure, health care providers training, and patient education. With these elements in place, telemedicine can become a powerful tool to promote health and improve the lives of people in the most disadvantaged areas of the world.

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## REVIEW ARTICLE

# The relationship with parents and the impact on adolescent academic performance

## La relación con los padres y el impacto en el rendimiento escolar del adolescente

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### Abstract

School performance expresses what a person has learned as a result of an instruction or training process. It is considered multifactorial, with the most important aspects being: Personal, family and academic, also considered as factors that influence school failure. For this research, it is important to know the impact that the family relationship with their parents has on the students on their school performance, focusing mainly on the situation of the General Secondary School “Mata Redonda”, with this objective the Sacks Sentence Completion Test was applied to 36 first grade secondary school students with an average less than or equal to 6.9. The instrument used consists of a 60-item questionnaire that aims to obtain data on four areas that represent the subject's adaptation: family, sex, interpersonal relationships and self-concept. After applying the test, it was concluded that the students studied within the sample do manifest emotional conflicts, both with the maternal and paternal figure, whether due to neglect, economic deprivation, alcohol and substance abuse, family disintegration and, most significantly, abandonment situations. Men are the ones who show the highest incidence of conflicts.

**Keywords:** Sacks sentence completion test; academic performance; secondary education; educational underachievement

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**Fecha de recepción:** 21/agosto/2024 | **Fecha de aceptación:** 03/septiembre/2024 | **Fecha de publicación:** 22/septiembre/2025

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### Resumen

El rendimiento escolar expresa lo que una persona ha aprendido como resultado de un proceso de instrucción o de formación, se considera multifactorial, siendo los aspectos más importantes: Personales, familiares y académicos, considerándose también como factores que influyen en el fracaso escolar. Para la presente investigación es importante conocer el impacto que produce en el alumno la relación familiar con sus padres en su desempeño escolar, enfocándose principalmente en la situación de la Escuela Secundaria General “Mata Redonda”, con este objetivo se les aplicó el Test de Frases Incompletas de Sacks a 36 alumnos de primer grado de secundaria con promedio inferior o igual a 6.9. El Instrumento utilizado consiste en un cuestionario de 60 ítems que tienen como finalidad obtener datos sobre cuatro áreas que representan la adaptación del sujeto: familia, sexo, relaciones interpersonales y concepto de sí mismo. Tras aplicar el test se concluyó que los alumnos estudiados dentro de la muestra sí manifiestan conflictos emocionales, tanto con la figura materna como paterna ya sea por descuido, carencias económicas, abuso de alcohol y sustancias, desintegración familiar y lo más significativo por situaciones de abandono. Siendo los varones los que muestran mayor incidencia de conflictos.

**Palabras clave:** test de frases incompletas de Sacks; desempeño académico; educación secundaria; bajo rendimiento educativo

## INTRODUCTION

Existing literature suggests that, in the academic environment, skill and effort are not equivalent terms, according to various authors, effort alone does not guarantee academic success, while the student skills begin to gain relevance and recognition within the classroom (López & Gómez, 2022). Nowadays, it is common that the student's effort is valued more than their demonstrated capabilities; in the same way, it has been highlighted that school performance is a manifestation of what is learned as a result of a process of instruction or training (Martínez & Ruiz, 2021); however, it is possible to observe that good intellectual capacity and aptitude do not always translate into high academic achievement.

School performance is a multi-factorial phenomenon that involves personal, family, and academic aspects; these three main elements play a fundamental role in the educational process (Fernández & Martínez, 2021), and their influence can be decisive in cases of academic failure.

Academic failure is understood as the inability of the individual to reach the expected achievements according to their abilities, which may be related to possible alterations in their personal development (González & Pérez, 2023).

Academic achievement is reflected in the grades obtained by students during the teaching-learning process, although taking numerical grades at the end of the school cycle as a reference may seem a limited approach, it is valuable when used to unravel a reality that goes beyond the adolescent themselves. This

makes possible to understand school achievement as a qualitative process, in which both subjective and objective elements present throughout the educational process are considered, thus making it possible to evaluate the quality of the education provided (López & García, 2022).

Academic achievement is a central concept in both education and psychology that stands out due to its importance in the evaluation of the effectiveness and quality of educational processes, since the grades obtained are not only the result of the efforts of educational institutions, and in particular, of teachers (Mendoza & Torres, 2023), but also function as an indicator and guide to the processes and products of an educational system; in addition, they allow informed decisions about teacher performance and the system as a whole (Álvarez & Ramírez, 2024).

During adolescence, it is common for academic performance and school achievement to experience a significant decline, as mentioned, at this stage the interests of adolescents focus on aspects such as self-image, progressive separation from the influence of parents and childhood teachers, belonging to a group, and the search for acceptance, as well as the first love experiences (García & Martínez, 2022). These new priorities can lead the adolescent to lose interest or motivation for study, as their attention is focused on resolving affective issues (Pérez & Fernández, 2023).

Middle school represents the last level of basic education and is offered in three modalities: general, technical and “telesecundaria” (a model that

combines distance and classroom learning). Each of these modalities covers three school cycles, during which adolescents are expected to acquire the fundamental tools for their future life; in Mexico, the universalization of elementary education has led to a significant growth in secondary education enrollment (González & Morales, 2021). In the 2005-2006 school year, this educational level covered almost six million adolescents in more than 32 thousand schools throughout the country, ranging from large urban schools to “telesecundarias” in remote communities (Ramírez & López, 2023). However, despite this expansion, challenges persist, such as the high dropout rate, with six out of every one hundred students dropping out of secondary school, partly due to the high failure rate (INEGI, 2024).

Parental involvement in their children's education is an essential factor, ranging from home training to commitment to school activities. This includes attending sports competitions, meetings with teachers and parent training courses (Sánchez & Fernández, 2022). It has been shown that students perform better when there is mutual understanding between parents and teachers about expectations and when there is constant communication about learning habits and academic progress (Vargas & Moreno, 2023). Teachers tend to communicate more with parents when they perceive that parents value such interaction, and it is most effective when it flows in both directions, differentiating between efforts to inform parents and those to encourage a bi-directional communication (García & López, 2024).

During adolescence, family and school contexts play a fundamental role in the psychological adjustment of the individual; previous research has shown that the existence of communication problems between parents and adolescent children is one of the family's risk factors most closely linked to the development of mental health problems in young people, such as depressive symptoms, anxiety and stress (Serrano & Jiménez, 2023). In the school setting, several factors that can negatively affect adolescent psychological adjustment have also been identified, such as low academic self-esteem and social integration problems, as well as peer victimization (Molina & Ramírez, 2024).

A study by Estevez and Misuti (2022) analyzed the influence of family communication (with father and mother separately) and school adjustment (school self-esteem and victimization problems) on adolescent mental health, evaluating indicators of psychological distress such as depressive symptomatology and perceived stress; the results of this study indicate that family and school factors are intertwined, and jointly contribute to the prediction of psychological distress, in particular, it is inferred that communication problems in the family context can trigger adjustment difficulties in the school environment, which, in turn, have a negative impact on the adolescent's mental health.

In a study of 1,417 adolescents of the low socioeconomic status, aged between 13 and 17 years, from 22 municipalities of the island of Tenerife, the relationship between the quality of parent-child

relationships and the adoption of lifestyles was analyzed (García, 2023). The results indicated that, at the beginning of adolescence, the lifestyles of the young people are generally healthy: no consumption of tobacco, alcohol or drugs is observed, no sexual relations have been initiated, there is satisfaction with body image, study is combined with leisure activities such as watching television or using the computer, and there is good communication and support from both parents, which is associated with good school adjustment.

However, during middle adolescence, a deterioration in lifestyles begins to show: adolescents start the consumption of tobacco and alcohol, although the latter moderately during weekends, in addition to increased knowledge of pregnancy prevention methods, contraceptives and sexually transmitted diseases, and a significant portion of the adolescents in the study initiate an active sexual life (Gómez & Martínez, 2023). Girls, in particular, tend to show dissatisfaction with their body image, present irregularities in meals, and sometimes experience feelings of loneliness, which puts them at risk of developing eating disorders or eating behavior disorders; on the other hand, boys present greater difficulties in their adaptation to the school environment and show lower academic achievement, which can lead them to experience situations of school failure, shared by 38% of students in Spain, and a possible early dropout (Ruiz & Sanchez, 2024).

Based on the reviewed literature, academic performance is the result of the interaction of

multiple factors, such as IQ, motivation towards school work, self regulation capacity, and the relations with peers and family; given the above, it is relevant to research the impact that the family relationship, particularly with parents, has on students' academic performance.

## **METHODS, TECHNIQUES, AND INSTRUMENTS**

The present research is correlational with a quasi-experimental design. The study population includes 103 first grade students (secondary education has three grades) from the Escuela Secundaria General (General Secondary School) "Mata Redonda", with a sample composed of 36 students who obtained a grade point average (GPA) of 6.9 or less. The Sacks Incomplete Sentences Test was applied and interpreted by psychologists, to obtain, according to the parameters, if there is a disturbance in any adaptive area of the subject; among those mentioned: family, sexuality, interpersonal relationships and self-perception, this evaluation is intended to know the relationship that exists with the father and mother of the student; in addition, the grades of the students were requested to the Principal Office (previous authorization) to identify those with a GPA lower than 6.9 and correlate the study variables.

This test is composed of 60 incomplete sentences divided into the following categories:

- Relationships with parents: designed to explore the individual's feelings and perceptions of their parents.

- Family Relationships: inquire about relationships with other family members.
- Interpersonal Relationships: shows how the individual perceives and manages their relationships with friends, co-workers, and other people in their social environment.
- Perception of Self: explores self-esteem, self-concept and how the individuals see themselves.
- Sexuality: provide information on attitudes and conflicts related to sexuality.

Thus, it helps to separate the direct influence of the relationship with parents from other areas of the individual's life by categorizing and analyzing the responses according to the different spheres of life that the test explores.

## RESULTS AND DISCUSSION

According to the analysis of the data, it was identified that, out of a total of 103 first grade students, 36 presented an GPA of less than 6.9, which represents 37% of the sample. Although this percentage could suggest that few students have low academic performance, it is important to consider that, due to the pandemic caused by SARS-CoV-2 and the agreements both internal and external to the institution to avoid school dropout, no grade was lower than six, in addition, constant opportunities for regularization were provided to improve GPAs.

In the selected sample, it is observed that the majority of students with low academic performance are males compared to females, as shown in Figure 1.

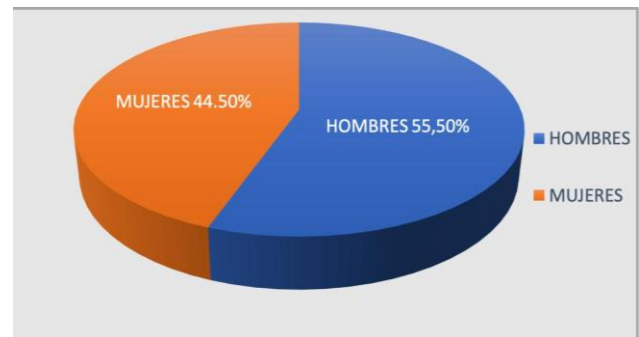


Figure 1. Distribution of the sample by gender

In relation to the quantitative results of the Sacks Incomplete Sentences Test, the data indicates conclusively that the participants present conflicts in the areas evaluated by the research; specifically, regarding the attitude of the students towards their parents, only 8.1% of the sample does not show any significant alteration in this area.

In contrast, 64.8% evidence a severe alteration in both areas, suggesting the need for therapeutic support to address the emotional conflicts present; in addition, 24.3% present a moderate alteration, indicating the existence of emotional conflicts, although these seem to be manageable without therapeutic intervention (Figure 2).

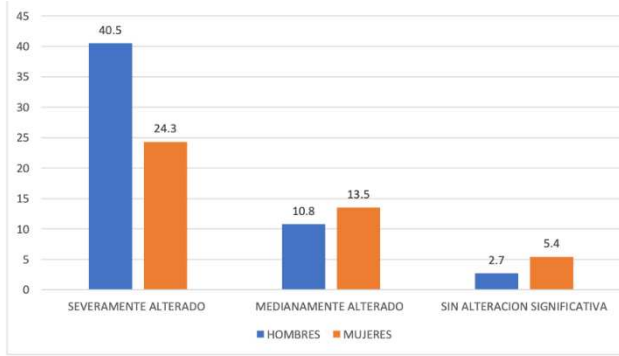


Figure 2. Sacks Test results of students reporting conflicts

This finding suggests that 89.1% of the sample presents manifest emotional conflicts, with a higher incidence in males, although the difference is not statistically significant, and is related to the low academic achievement observed in these students.

These results are consistent with the existing literature, which indicates that family relationships, and especially the relationship with parents, are a common source of emotional stress during adolescence and young adulthood; the low proportion of participants without alterations could also reflect a social and family environment where conflicts are more prevalent, which warrants consideration in the intervention and support provided to this population (López & Gámez, 2019).

On the other hand, the results of the participants with a severe alteration in both evaluated areas reinforce the urgent need for therapeutic interventions; these data not only confirm the presence of deep emotional conflicts, but also underline the severity of these, which could have significant repercussions on the long-term psychological well-being of the affected

individuals. In their study, González & Rodríguez (2021) mention that such severe alterations could be linked to dysfunctional communication patterns, unfulfilled expectations, or unresolved conflicts in the family nucleus, making imperative that this group receive specialized support that allows them to work on their internal conflicts and improve their family relationships.

Participants with moderate impairment indicate that, although emotional conflicts exist, they are not so severe as to require immediate therapeutic intervention; this group could benefit from emotional management and conflict resolution strategies to help them process and overcome their difficulties effectively, before these problems escalate. Serrano & Martínez (2020) indicate that, with the right support, individuals in this category can significantly improve their relationship with their parents, reducing the risk of conflicts escalating.

Overall, these results reflect a worrisome picture regarding the emotional health of the participants, particularly in relation to their parents. The differences in the levels of emotional disturbance underscore the importance of differentiated interventions tailored to the specific needs of each group, ranging from the promotion of coping skills for those with moderate disturbances to intensive therapeutic intervention for those who evidenced severe disturbances; this personalized approach is crucial to effectively address the emotional conflicts detected in this research.

## CONCLUSIONS

The results obtained provide a comprehensive and worrying view of the emotional state of this population, revealing the prevalence of significant tensions in family relationships and underscoring the need for interventions that effectively address these problems. First, it is important to highlight that the minority did not present significant alterations in their relationship with their parents, indicating that most of the young people evaluated experienced some type of emotional conflict in this area.

The fact that more than half of the participants evidenced severe impairments in both areas evaluated is particularly alarming, not only confirming the existence of severe impairments but also the existence of deep emotional conflicts, but also underline the seriousness of these, which could have significant repercussions on the long-term psychological well-being of the affected individuals, and may be linked to dysfunctional communication patterns, unfulfilled expectations or unresolved conflicts within the family nucleus. Therefore, it is a priority for this group to receive specialized support that allows them to work on their internal conflicts and improve their family relationships. Therapeutic intervention in these cases is not only necessary, but urgent, to prevent the development of more serious psychological disorders and promote healthy emotional development.

On the other hand, the participants who presented moderate alterations indicate the presence of emotional conflicts that, although not so serious as to

require immediate therapeutic intervention, should not be dismissed, so this group could benefit significantly from emotional management and conflict resolution strategies to help them process and overcome their difficulties effectively, before these problems worsen. Overall, the results of this study highlight the high prevalence of emotional conflicts among the young people evaluated, particularly in their relationship with their parents, which raises a critical concern regarding the emotional well-being of this population.

The differences in the levels of emotional disturbance observed among participants underscore the importance of adopting a differentiated intervention approach, ranging from the promotion of coping skills for those with moderate disturbance to intensive therapeutic intervention for those with severe disturbance; this personalized approach is crucial to effectively address the emotional conflicts detected in this research, further reinforcing the need for a multidisciplinary approach in which mental health professionals, educators and families work together to provide the necessary support to these young individuals.

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## REVIEW ARTICLE

# Virtual learning environments as a support tool in the teaching-learning process

## Entornos virtuales de aprendizaje como herramienta de apoyo en el proceso enseñanza aprendizaje

Jaime Cruz Casados, Laura Nelly Cruz Casados, María José González Cuellar\*

### Abstract

In recent years, learning models have increasingly integrated technologies into educational centers, responding to emerging demands and needs in education and facing the challenges of new generations of students. This research aimed to analyze the use and evolution of the incorporation of technologies in education to improve the teaching-learning process of university students. An exhaustive literature review was carried out on the topic, including research by several authors on the evolution of virtual learning environments and their benefits for students. The results show a favorable impact on both teachers and students, since the use of learning platforms significantly helps in the design of self-regulatory activities. The information obtained in this research serves as motivation to continue studying how technologies improve the educational process and provide teachers with new tools that support face-to-face classes and improve autonomous and regulated learning.

**Keywords:** virtual environments; learning; teaching; students; technologies

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**Fecha de recepción:** 21/agosto/2024 | **Fecha de aceptación:** 03/septiembre/2024 | **Fecha de publicación:** 22/septiembre/2025

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### Resumen

En los últimos años, los modelos de aprendizaje han integrado cada vez más tecnologías en los centros educativos, respondiendo a las demandas y necesidades emergentes en la educación y enfrentando los desafíos de las nuevas generaciones de estudiantes. Esta investigación tuvo como objetivo analizar el uso y evolución de la incorporación de tecnologías en la educación para mejorar el proceso enseñanza aprendizaje de los estudiantes universitarios. Se llevó a cabo una revisión bibliográfica exhaustiva sobre el tema, incluyendo investigaciones de varios autores sobre la evolución de los entornos virtuales de aprendizaje y sus beneficios para los alumnos. Los resultados muestran un impacto favorable tanto en los docentes como en los estudiantes, ya que el uso de plataformas de aprendizaje ayuda significativamente en el diseño de actividades autorregulatorias. La información obtenida en esta investigación sirve como motivación para continuar estudiando cómo las tecnologías mejoran el proceso educativo y proporcionan a los docentes nuevas herramientas que apoyan las clases presenciales y mejoran el aprendizaje autónomo y regulado.

**Palabras clave:** entornos virtuales; aprendizaje; enseñanza; estudiantes; tecnologías



## INTRODUCTION

Talking about learning environments involves approaching different definitions proposed by several authors. According to Juanes, Munévar & Cándelo (2020), a learning environment should include a student and a workspace where they can interact with tools and devices. From a constructivist perspective, this learning space should also allow interaction between students to work and support each other, facilitating problem solving and learning (Farfán et al., 2023).

Along the same lines, Sanchez (2021) offers a more formal definition, describing a learning environment as a space that provides the necessary conditions for students to discover and appropriate knowledge. Obermeier (2023), on his side, suggests that the learning environment is related to work organization, structure, authority, and time management.

Today, these learning environments pose pedagogical and technical challenges for both teachers and institutions of higher education, as the role of the teacher and student is constantly evolving to adapt to these new educational contexts (Medina, 2021).

Nieto (2022) reinforces this idea by considering that the classroom environment is fundamental to the physical, social, and cognitive development of students, highlighting the importance of the integral development from the people involved in the educational process, promoting their critical social integration. Lahera & Perez (2021) argue that the learning environment should not only be limited to

the classroom but should include all the elements that currently allow interaction between teachers and students, encouraging strategic or heuristic learning through them.

Digion & Alvarez (2022) mention that the learning environment is a socio-psychological environment where an interaction of knowledge between students and teachers is produced; these interactions set up a network of social, psychological, cultural and institutional variables, which allows the personalization of the learning environment by both actors, teachers and students. In this context, Hernandez, Mendez & Fernandez (2021) believe that a learning environment should incorporate certain key principles:

- It should promote interaction between the teacher and the students, as well as amongst students, with the goal of aligning common learning goals.
- It must have enough material to enable meaningful cognitive learning.
- It must be creative and diverse, in order to encourage the development and fluency of the cognitive processes from students.
- It should offer different scenarios, allowing the student to move comfortably between them.
- It should be developed by all participants in the learning process, helping students to feel included and comfortable working in it.

Derived from the preceding, Cámac et al. (2023) state that, in these settings, students not only learn content from various disciplines, but also develop other cognitive and intellectual skills related to these

learnings, such as reasoning, inventing, solving diverse types of problems, representing reality and making value judgments, encouraging in turn the development of communication skills, allowing greater interaction between them and their environment. For this reason, pedagogical design is essential when designing these environments, being necessary to consider all ongoing factors that currently influence knowledge and not leave the creation of learning environments at random or exclusively to technology (Largo et al., 2022).

For Gamarra et al. (2023), in schools with a single classroom per grade, teachers face a great challenge, since the communication channels and their frequency are diverse and high, it is also common to observe multiple children chatting simultaneously, which can be further complicated in large groups, significantly increasing the number of students requiring attention (Cruz et al., 2023). Due to this reason, teachers often try to motivate students by offering rewards for both individual and group progress, with the goal of keeping children always motivated (Pascual, Lopez & Velasco, 2023).

González (2022) proposes that the quality of classroom instruction is directly related to the competence of the teacher, however, disinterest, discouragement and lack of commitment on the part of some teachers is currently observed, largely attributable to external factors that affect their performance; this situation significantly influences learning development, which may result in some

students receiving a better instruction than others depending on their teacher (Mamani, 2024). However, as Freire (1994) mentions, it cannot be affirmed that a student under the tutelage of an incompetent teacher is necessarily incapable and lacks responsibility, nor that a student with a competent and serious teacher is automatically responsible and capable (Arrillaga, 2021).

Tigua & Bracno (2023) make a big impact by comparing current education to bringing students to the best restaurant in the world and forcing them to consume only the daily special; this analogy is shared by Pastora & Fountain (2021), who suggest that ideal schools should serve as buffet tables where each student can select what they want in the quantities and at the pace they prefer, even starting with dessert if they want.

Villagómez et al. (2020) have been considering for more than two decades the need to integrate technologies into education to improve learning environments through computer and telecommunications systems, gaining even more relevance today with the advancement of Information and Communication Technologies (ICTs). According to Perez & Lopez (2020), human beings use all their senses to interact with their environment, meaning teachers can take advantage of technological tools to develop new ways of transmitting information, encouraging more effective feedback, and enhancing the learning process.

Marimon et al. (2022) identified more than two decades ago the main problems of the current educational model, which remain relevant today; those are: difficulty to customize the teaching-learning process, an almost exclusive focus on teaching rather than learning, lack of clear objectives, and in many explicit cases, prioritize the end result as the main value, neglecting the learning process, encouraging dependency by setting aside self-learning, among others. In addition, advances in ICT have shown the lack of preparation of many teachers to adapt their knowledge to the needs of students, as the increase in information available on the web has created a gap in pedagogical knowledge, leading some teachers to continue using obsolete teaching methods in the face of advances in social sciences and technologies (Wheel & Soriano, 2024).

Castro (2022) maintains that the use of ICT will radically transform learning environments, altering the role of the teacher from being a mere knowledge transmitter, to act more as a guide or mediator of learning; this transition should be encouraged by manipulating certain didactic elements that facilitate the creation of habits in students, allowing them to develop skills to search, select and process information (Tenorio & Deroncele, 2023). Students, on their side, will benefit from being in more open and flexible learning environments, which will allow them to develop new competences, moving from being passive subjects and memorizers in the learning process to having more active control of their own learning resources (Aguilar, Padilla & Loop, 2022).

## VIRTUAL LEARNING ENVIROMENTS

Defining a virtual learning environment presents some challenges due to the diversity of interpretations among authors (Ramos & Talero, 2023). While some definitions are too broad, others are limited; a fairly appropriate proposal is the one mentioned by Cruz et al. (2020), describing virtual learning environments as a new form of educational technology that offers diverse teaching opportunities; similarly, Cruz et al. (2020) conceptualize virtual learning environments as a set of information sharing and communication computing tools, that integrate a wide range of materials and resources designed to improve the learning process.

Zangara & Sanz (2020) describe these environments as technology-mediated spaces for personal or group inquiries, where students perform activities that enable them to achieve meaningful learning. In these settings, both the student and the teacher control learning activities, using information sources and knowledge-building tools to solve problems (Nieto, 2022).

As mentioned above, different criteria and concepts can be found around the definition of virtual learning environments (Parra & Molina, 2023); for some authors, such as Aparicio & Ostos (2021) these environments are simply communities of human interrelationships. On the other hand, Garcet et al. (2024) define them as virtual spaces based on the use of information and communication tools, considering them only technological systems. Other authors prefer to use the expression learning

environments (Candela & Benavides, 2020), classrooms without walls (Anriquez, 2021), or even computer environments of human learning (Veitz, 2022) and hyper interactive learning environments (Muguercia et al., 2022).

## **DEVELOPMENT OF VIRTUAL LEARNING ENVIRONMENTS**

The meaningful advances in information and communication technologies have promoted an exponential growth in the use of technological tools in education, especially in the field of virtual learning (Guerrero, Sandoval & Velez, 2024). It has become increasingly common to witness the development of tools ranging from simple content distribution to comprehensive learning management and administration, for several years, virtual learning environments have been discussed as a natural evolution in this context (De la Iglesia, 2020).

Regarding the aforementioned, Quintero (2020) states that each of these tools fulfills specific functions; content distribution systems, known as Content Management System (CMS), are responsible for document creation and organization. At the same time, Learning Management Systems (LMS) are used to create, manage, distribute, monitor, and evaluate online courses, and also include tools to ease the communication and collaborative work (Sánchez & Peñarreta, 2023). Lastly, Learning Content Management Systems (LCMS), go beyond by including the publication of results and a section for the integrated content management (Spanish & Rocha, 2020).

Quispe et al. (2023) note that the use of these tools in the learning processes has expanded, not only because of the ability to shorten distances, which is now a fundamental reason, but also because of the possibility they offer teachers to create new forms to work. More tools are emerging in both the payment market and open access environment, according to Losada, Cardenas & Vasquez (2020), every virtual learning environment consists of five main elements: student, teacher, environment, content, and communication tools.

Crespo, Santamaria & Hernández (2021) emphasize the importance of using technologies that are not only appropriate but also mediate. These technologies allow both synchronous and asynchronous communication, establishing a link between educational-technological cooperation, and social interactions between the teacher and the student, or between peers, better aligning with contemporary learning processes. These authors identify three essential components from different points of view:

- Technological: Technologies should be best suited to improve the connection between the pedagogical model and the tool.
- Cultural: It is critical to consider the social organization of the process, including aspects like time and space.

- Learning: This refers to the activities, learning materials, support and evaluation that make up the educational process.

According to Pastora & Sources (2021), social interaction is fundamental in today's learning environments, as it favors the acquisition, administration, transformation, and dissemination of knowledge, this is related to the proliferation of virtual learning environments, which makes it necessary to innovate to increase their use and appeal. Today, there are numerous environments, including the Modular Object Oriented Dynamic Learning Environment (MOODLE), created by Martin Dougiamas in 2002, known for its easy handling and adaptability; also, another notable environment is Google Classroom, launched in 2012 (Baquerizo et al., 2022).

## **VIRTUAL LEARNING**

The use of information and communication technologies to promote teaching is showing notable results, highlighting their educational and pedagogical value such as the one required by meaningful learning (Torres et al., 2025). These technologies, in some cases, become essential tools that guide and encourage new methods of self-study in students (Muñoz et al., 2024). According to Marrufo & Spine (2021), these e-learning methodologies are as effective as traditional class lecture methods, making students learn more interactively.

In the context of virtual learning, Alfonso (2015) points out that there must be a harmonious

relationship between all the factors involved, especially the relationship between teachers, technology, and students, without forgetting the macro-social context and the teaching-learning process (Cazan & Maican, 2023). This interaction promotes the development of knowledge through virtual environments, where the data and information provided by the teacher are organized and stored by students through their own cognitive processes (Muñoz & Gutierrez, 2024).

Virtual learning has numerous advantages, as it only requires an electronic mean to start the learning process at any moment or place and also allows simultaneous peer-to-peer interaction (Nuñez et al., 2024). This flexibility allows learning to be customized to the needs and availability of the student, and if teachers take advantage of the versatility of online platforms, they can advance content in digital format for students to review before attending classes, currently known as Flipped Classroom (Chávez, 2024).

## **METHODS, TECHNIQUES, AND INSTRUMENTS**

A comprehensive literature review of articles on virtual learning environments in higher education was carried out using specialized databases in thesis, scientific articles and indexed journals search engines, selected for their high impact and relevance in the educational field. The scientific content collected is essential to support and consolidate scientific theories and concepts, with the aim of transforming society into a globally competitive landscape.

The research took a qualitative approach with a non-experimental and descriptive design. The study was characterized as descriptive-analytical, based on objective verifications of primary studies extracted from both national and international scientific articles, which were selected through a rigorous process that included inclusion and exclusion criteria clearly defined. The inclusion criteria included studies published in the last five years, articles that directly addressed the theme of virtual learning environments in higher education, and that came from journals with a high impact factor; in addition, the exclusion criteria ruled out studies with insufficiently developed methodological approaches, those that did not offer clear empirical results or that focused on educational levels other than higher education.

Inquiry was used as the main technique, and systematic analysis of literature was used as the methodological tool; the method used began with the identification of particular facts using an inductive analytical procedure, which allowed general conclusions to be drawn through global observations.

## **RESULTS AND DISCUSSION**

In the bibliographic review and descriptive analytics, information about virtual learning environments was searched for in the main databases, such as Scopus, WoS, Scielo and Dialnet. Also, thesis, scientific articles and indexed journals search engines databases were also consulted, considering only publications from the last five years. The results of these searches retrieved 2,970 documents on Google Academic, 547

on Redalyc, 645 on Dialnet, 66 on Web of Science and 1,149 on Scopus. This allowed for a thorough review, analysis, comparison, and synthesis of the results of the selected publications in relation to the virtual classrooms (Table 1).

## **CONCLUSIONS**

One of the main findings is that virtual learning environments facilitate greater interaction and collaboration among participants, as tools such as forums, video conferencing, and messaging platforms enable constant, two-way communication, enriching the educational process and promoting a sense of community among students, this interaction not only improves content understanding, but also builds social and teamwork skills.

Flexibility and accessibility are other notable advantages of these environments, allowing learning to occur anytime and anywhere, overcoming geographic and temporal limitations, this feature being especially useful for students with varied schedules or residing in remote areas, thus democratizing access to education and providing equal opportunities for all.

Virtual environments also promote learning personalization, adapting content and activities to the individual needs of each student; systems such as Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) facilitate continuous tracking and evaluation of student progress, enabling customized adjustments that optimize learning. The role of the teacher in these

settings is crucial: far from being replaced by technology, teachers act as facilitators and guides, helping students make the most of technological tools and develop their own learning strategies, apart from her or his guidance, critical to ensure their effectiveness.

The integration of ICT into education has driven the adoption of new pedagogical methods, such as the flipped classroom and project-based learning; these approaches promote greater active student engagement and the development of skills essential for the 21st century, such as critical thinking and problem solving. However, research also identifies important challenges that need to be addressed to maximize the potential of virtual learning environments, including the need for adequate technology infrastructure, the persistent digital gap in

many regions, and resistance to change by some teachers and students, considering that overcoming these challenges requires technology investments, as well as policies and programs for ongoing training and support.

Virtual learning environments have been consolidated as a powerful and versatile tool in the teaching-learning process, since, by promoting interaction, flexibility and customization, these environments have the potential to significantly improve the quality of education. However, in order to fully realize these benefits, it is essential to address existing challenges and ensure that both teachers and students are equipped with the necessary skills and resources, and with an appropriate approach they can decisively contribute to better preparing students for the challenges of the future.

## Virtual learning environments as a support tool in the teaching-learning process

**Table 1.** *Systematization of articles on virtual learning environments*

Author	Contribution	Results
Recio Saucedo, M. A., & Cabero Almenara, J. (2005)	Study the relationship between virtual learning environments and student satisfaction levels	Elevated levels of student satisfaction due to flexible learning schedules and access to various resources.
Arturo, R. Z., Yajaira, A. M., & Reyes, K. A. D. (2020)	Surveys students' perceptions and attitudes toward using virtual learning environments in their educational experience	Positive insights and greater comfort with technology-enhanced learning
Monroy Vásquez, J. O. M. V., & Moreno, P. A. (2020)	Studies how the use of virtual learning environments affects student retention and persistence in their studies	Higher retention rates and lower dropout rates due to attractive and flexible learning environments
de Souza Godinho, S., Rivela, C. V., Medrado, S. O., Marmo, J., & Lanuque, A. (2021)	Examines the role of virtual learning environments in promoting inclusive education for students with diverse learning needs	Improved accessibility and inclusion, enabling students with disabilities to participate more effectively
Higuera, A., & Rivera, E. (2021).	Examines the effect of virtual learning environments on student academic outcomes	Better academic performance and greater participation in coursework.
Murcia, N. M. M., Mayorga, D. A. C., & Contreras, J. L. G. (2021)	Compares traditional classroom environments to virtual classrooms in terms of student learning outcomes	Comparable or higher learning outcomes in virtual classrooms compared to traditional environments
Ponce, J. K. M. (2021)	Analyzes various digital tools used in virtual environments and their effectiveness in improving learning	Significant improvement in learning outcomes, particularly in understanding and retention
Real-Loor, C. M., & Marcillo-García, C. E. (2021)	Discusses transition to digital learning environments and their integration into higher education	Successfully adapting to digital learning environments that lead to improved educational experiences
Padilla, H. A. S., Perera, J. J. D., Amezcua, C. D. A., & Fernández, M. S. (2022)	Focus on how virtual learning environments affect student motivation and interest in course material	Increased motivation and proactive learning behaviors among students using virtual learning environments
Palacios-Núñez, M., Deroncele-Acosta, A., & Cruz, F. F. G. (2022)	Explores the benefits of collaborative learning activities facilitated through virtual learning environments	Improved critical thinking skills and improved performance on group projects.
Ramírez, L. E. L., Vega, M. I. P., Gutiérrez, P. T. V., Villa-Cruz, V., López, J. O. O., & Reyes, L. J. L. (2022)	Discusses the use of virtual labs in science and engineering careers	Enhanced practical skills and understanding of complex concepts through virtual experimentation
Arango-Vásquez, S. I., & Manrique-Losada, B. (2023).	Case study on the effectiveness of virtual learning environments to foster collaboration among students	Improved collaboration skills and improved group project outcomes
Lecca, S. V. (2023)	Researches the use of gamification in virtual learning environments and its impact on student engagement and academic success	Increased student participation and academic performance due to interactive and motivating elements
Navarro-Dolmestch, R. (2023)	Studies the challenges of maintaining academic integrity in virtual learning environments	Developing new strategies to maintain academic integrity while using virtual learning environments
Vera, S. T., & Vargas, O. L. (2023)	Investigates the impact of virtual learning environments on students' confidence in their academic skills	Increased self-efficacy and confidence in managing academic tasks through virtual learning environments

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## REVIEW ARTICLE

# State of art. Chronic Liver Damage in End-Stage Renal Disease and Hemodialysis

## Estado del arte. Daño hepático crónico en Enfermedad Renal Terminal y Hemodiálisis

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### Abstract

Cirrhosis, an advanced stage of liver fibrosis, has among its main causes alcohol consumption, obesity, and viral infections. In the last decade, this condition has been extensively studied in patients with chronic kidney disease (CKD) on hemodialysis (HD), a population with similar risk factors for infections. It has been shown that hepatitis C virus (HCV) not only contributes to kidney damage through multiple mechanisms, but it can also complicate CKD, increasing morbidity and mortality. This study conducted a review of the scientific literature between 2000 and 2023, covering topics such as HCV prevalence in HD CKD, liver damage progression, co-infections, direct-acting antiviral treatment, and prevention measures in HD units. Results show prevalences above 10% in developed countries and up to 60% in developing regions. In addition, hepatitis B virus and emerging viruses such as SEN and torque teno are common as co-infections in these areas. The need to standardize HD procedures, reduce blood use and promote periodic assessment of liver damage is highlighted, seeking to reduce new HCV infections by 90%.

**Keywords:** Hepatitis C virus; Cirrhosis, Hepatitis; Hemodialysis; direct acting antivirals

### Resumen

La cirrosis, estadio avanzado de fibrosis hepática, tiene entre sus principales causas el consumo de alcohol, obesidad e infecciones virales. En la última década, esta condición ha sido ampliamente estudiada en pacientes con enfermedad renal crónica (ERC) en hemodiálisis (HD), una población con factores de riesgo similares para infecciones. Se ha demostrado que el virus de la hepatitis C (VHC) no solo contribuye al daño renal mediante múltiples mecanismos, también puede complicar la ERC, incrementando la morbilidad y mortalidad. Este estudio realizó una revisión de la literatura científica entre 2000 y 2023, abarcando temas como la prevalencia del VHC en ERC en HD, la progresión del daño hepático, coinfecciones, el tratamiento con antivirales de acción directa y las medidas de prevención en unidades de HD. Los resultados muestran prevalencias superiores al 10% en países desarrollados y hasta un 60% en regiones en vías de desarrollo. Además, el virus de la hepatitis B y virus emergentes como SEN y torque teno son comunes como coinfecciones en estas áreas. Se subraya la necesidad de estandarizar los procedimientos en HD, reducir el uso de sangre y promover la evaluación periódica del daño hepático, buscando reducir las nuevas infecciones por VHC en un 90%.

**Palabras clave:** Virus de la Hepatitis C; Cirrosis; Hepatitis; Hemodiálisis; antivirales de acción directa

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**Fecha de recepción:** 21/agosto/2024 | **Fecha de aceptación:** 03/septiembre/2024 | **Fecha de publicación:** 22/septiembre/2025

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## INTRODUCTION

Cirrhosis is the most advanced stage of liver fibrosis, and its main causes include alcohol consumption, obesity, and viral infections (Ou et al., 2024). Among viral causes, hepatitis C virus (HCV) stands out as the cause of chronic infection in approximately 70% of the cases, with a risk of cirrhosis development up to 30%. HCV infection is primarily transmitted parenterally, through blood transfusions, needle sharing among intravenous drug users, and unsafe practices in hospitals and dental offices. In Mexico, men aged fifty represent the most affected population (Panduro et al., 2011). Patients with chronic kidney disease (CKD) using peritoneal dialysis (PD) and hemodialysis (HD) are a high-risk group (Gómez-Gutiérrez, 2015).

The course of hepatitis C is usually asymptomatic, which is detected between 20 to 30 years after infection due to complications related to hepatic decompensation. However, HCV-infected CKD patients may have a more complex disease, since diagnosis is difficult due to the high frequency of occult hepatitis in this population (Timothy et al., 2020). Diagnosis of infection represents a global challenge, especially in CKD patients, who have clinical and biochemical condition like liver disease, further delaying the identification of liver damage due to symptom masking (Bruguera et al., 1990).

This review collects scientific evidence on the prevalence of HCV in CKD and HD patients, the impact on liver health, and provides a brief description of the use of direct-acting antivirals

(DAAs) for the treatment of HCV. The objective is to provide a summary of scientific evidence that contributes to increase HCV detection, promoting early diagnosis of liver damage, and reducing morbidity in this high-risk population.

## METHODS, TECHNIQUES, AND INSTRUMENTS

A narrative review of the scientific literature published between 2000 and 2023, in English and Spanish, was performed, systematically consulting databases such as PubMed, Scopus, Web of Science and ScienceDirect, known for their scientific rigor and broad coverage in biomedical sciences.

The literature search was designed based on recommendations of quality criteria for narrative reviews (Baethge et al., 2019), to ensure the relevance and comprehensiveness of the collected information. The following were used as key words and controlled descriptors (MeSH and DeCS): Hemodialysis, Hepatitis C Virus, Chronic Liver Damage, Viral Infections and Blood Transfusions. Boolean operators were used to expand search sensitivity: (“Hepatitis C Virus” AND “Hemodialysis”) OR (“Hepatic Damage” AND “End-Stage Renal Disease”).

The search process yielded 487 initial articles. Following the application of inclusion and exclusion criteria, sixty-five duplicates were removed, and 380 articles were discarded since they did not meet the objectives of the study, leaving forty-two articles to be included for detailed analysis. These studies were

the basis of this review, with an emphasis on three main axes: HCV prevalence in patients with HD CKD, mechanisms of liver damage progression, and DAA efficacy in this population. This procedure enabled integration of a broad, up-to-date, and critical picture of the impact of HCV in CKD patients undergoing hemodialysis, following internationally recognized methodological standards for high-quality narrative reviews.

### **PREVALENCE OF HCV IN HEMODIALYSIS PATIENTS**

The overall prevalence of HCV in patients with CKD on hemodialysis has been evaluated by epidemiological studies, being in the range of 24.3%, with significant regional variations. In Eastern Europe, a prevalence of 48.6% has been reported; in Indonesia, of 63.6%, and an overall mortality rate of 38.7% (Kenfack et al., 2024). In high-income countries, such as the United States, Japan, and England, the average prevalence is 13.5%, ranging from 2.6% to 22.9%.

This variability is primarily associated with the time on hemodialysis, male sex, African descent race, diabetes, co-infection with hepatitis B virus (HBV), kidney transplant, and alcohol or illicit substance use in the past 12 months (Fissell et al., 2004). A meta-analysis of studies conducted in Latin America estimated a prevalence of hepatitis C in CKD and hemodialysis of 10.7%, with rates ranging from 26.1% in Argentina to 6% in Brazil (Huarez et al., 2022).

### **HCV TRANSMISSION MECHANISMS ON HEMODIALYSIS**

The hemodialysis procedure involves frequent manipulation of the circulatory system, increasing the risk of transmission of infections. HCV is transmitted by contact with contaminated blood, transfusions, or dialysis equipment not properly disinfected. The regulation of blood handling and disposal practices in many countries has significantly reduced transfusion-borne pathogens; However, in countries where blood banks do not routinely test for HCV, transfusions remain a source of risk (Jadoul et al., 2019). In resource-limited regions, the reuse of dialysis equipment is a key factor in HCV transmission, increasing the risk of cross-transmission if strict disinfection protocols are not enforced. Inadequate infection control practices during vascular access also pose a considerable risk (Pavlina et al., 2018).

### **HEPATITIS C AND HEMODIALYSIS**

The World Health Organization (WHO) estimates that approximately fifty-eight million people have hepatitis C, turning it into a public health problem, particularly in developing countries and in vulnerable populations such as hemodialysis patients (WHO, 2023). The relationship between CKD on hemodialysis and HCV is well known; in India, the detection in hemodialysis patients is critical for a timely treatment, reducing the risk of progression to an advanced liver damage and hepatocellular carcinoma (Kalita et al., 2021). In Peru, an HCV prevalence of 35.1% has been reported in hemodialysis patients, of which 20.11% had viral load (Padilla-Machaca et al., 2022).

## CO-INFECTIONS AND OTHER RISK FACTORS

Co-infection with other viruses, such as HBV, SEN virus (SENV), and torque teno virus (TTV), complicates the management of HCV patients on hemodialysis. In Egypt, 50.8% of HCV patients on hemodialysis presented an occult HBV infection, 29% by TTV, and 11.5% by SENV (Amer et al., 2019).

Progression of liver damage in patients with HCV In patients with CKD and hemodialysis, HCV infection tends to rapidly progress into cirrhosis, liver failure, and hepatocellular carcinoma, in part due to elevated viral loads and compromised immune function secondary to CKD. Co-infection with other hepatotropic viruses, such as HBV and SEN-V, may further accelerate this progression (Bruguera et al., 1990).

## TREATMENT AND MANAGEMENT OF HEPATITIS C ON HEMODIALYSIS

Treatment of hepatitis C in patients with CKD and hemodialysis has progressed significantly in recent years. Direct-acting antivirals (DAAs) have proved to be highly effective, achieving sustained viral response rates greater than 90%. These treatments, free of interferon and ribavirin, are pangenotypic and do not require viral genotyping for drug selection.

In addition, they allow for the estimation of liver fibrosis by indirect indices, such as FIB-4 and APRI, which are useful in this population where a liver biopsy is often contraindicated. DAAs present a

fixed combination of target-specific and safe molecules, validated in studies that included patients with CKD and hemodialysis (Akil et al., 2023).

## RESULTS AND DISCUSSION

The prevalence of hepatitis C virus (HCV) infection in patients with chronic kidney disease (CKD) and undergoing hemodialysis (HD) is high and represents an important risk factor for the development of chronic liver damage. According to Carnalla et al. (2022), transmission mechanisms associated with HD and transfusion procedures increase the risk of infection.

Despite improvements in infection control practices in recent decades, infection rates in resource-limited countries remain high, reflecting the need to strengthen preventive practices in these settings (Greeviroj et al., 2022). Table 1.

**Table 1.** Recommended Protocols for HCV Control in HD Centers

Protocol	Description	Source
Dedicated Equipment	Using separate machines	HCV Pavlina et al., 2018
Disinfection Protocols	Rigorous cleaning of equipment and areas	of CDC, 2023

Patients with HD HCV infection often have co-infections with other hepatotropic viruses, such as hepatitis B virus (HBV), SEN-V, and TTV, aggravating liver damage and accelerating the progression to conditions such as cirrhosis and hepatocellular carcinoma. In particular, HBV co-infection increases mortality in these patients,

highlighting the importance of implementing systematic vaccination and screening programs in at-risk populations (Fabrizi et al., 2021).

In developing countries, where health infrastructure is limited, there are significant challenges to the prevention and control of hepatitis C virus (HCV) in hemodialysis (HD) centers.

Best practices include the use of dedicated HD equipment for HCV patients, as well as the implementation of rigorous disinfection protocols. In addition, it is necessary to reduce unnecessary blood transfusions, as they represent a considerable source of virus transmission in regions where blood banks do not perform systematic testing for HCV (Pavlina et al., 2018).

## CONCLUSIONS

In Mexico, advances in the detection and control of HCV in the general population have been limited, hence, strategies are required to increase the number of tests in risk groups, such as HD patients. This includes applying CDC recommendations, which propose screening all adults for HCV antibodies at least once in a lifetime (CDC, 2023).

Further research on interactions between HCV and other hepatotropic viruses is needed, as co-infections with viruses such as HBV, V-SEN, and TTV pose additional risks, especially in regions such as Asia and Africa. Such co-infections may aggravate liver damage in patients, highlighting the importance of establishing appropriate vaccination and screening programs for these viruses in vulnerable populations.

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## REVIEW ARTICLE

# Virtual Applications with Artificial Intelligence for Learning of Children with ASD

## Aplicaciones Virtuales con Inteligencia Artificial para el aprendizaje en niños con TEA

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### Abstract

Virtual applications with artificial intelligence (AI) are revolutionizing special education, offering new opportunities for learning for children with Autism Spectrum Disorder (ASD), as they provide personalized learning experiences that adapt to the individual needs of each child, effectively addressing areas such as communication, social interaction and motor skills, maintaining children's interest, but also promoting continuous and meaningful development. The purpose of this article was to examine the impact of AI on virtual applications aimed at learning and skill development in children with ASD, identifying how these interact with children, offering personalized experiences that address and strengthen the areas where each individual presents difficulties. To carry out this review, a documentary analysis method was used, collecting and examining a wide range of relevant studies and academic sources. The findings from this analysis provide a deeper understanding of the capabilities of AI in special education and offer practical recommendations for parents, educators and application developers, and underline the importance of further developing and refining these technologies to offer increasingly effective support to individuals with ASD. It is concluded that the integration of these tools into the family and school environment maximizes their benefits, suggesting that artificial intelligence has the potential to significantly transform special education.

**Keywords:** artificial intelligence; applications; education; ASD; children

### Resumen

Las aplicaciones virtuales con inteligencia artificial (IA) están revolucionando la educación especial, ofreciendo nuevas oportunidades para el aprendizaje en niños con Trastorno del Espectro Autista (TEA), ya que éstas proporcionan experiencias de aprendizaje personalizadas que se adaptan a las necesidades individuales de cada niño, abordando de manera efectiva áreas como la comunicación, la interacción social y las habilidades motoras, manteniendo el interés de los niños, promoviendo así un desarrollo continuo y significativo. El propósito de este artículo consiste en examinar el impacto de la IA en aplicaciones virtuales destinadas al aprendizaje y desarrollo de habilidades en niños con TEA, identificando cómo estas interactúan con los niños, ofreciendo experiencias personalizadas que abordan y fortalecen las áreas donde cada individuo presenta dificultades. Para llevar a cabo esta revisión, se empleó un método de análisis documental, recopilando y examinando una amplia gama de estudios y fuentes académicas relevantes. Los hallazgos obtenidos a partir de este análisis proporcionan una comprensión más profunda de las capacidades de la IA en la educación especial y ofrecen recomendaciones prácticas para padres, educadores y desarrolladores de aplicaciones, además subrayando y perfeccionando estas tecnologías para ofrecer un apoyo cada vez más eficaz a las personas con TEA. Se concluye que la integración de estas herramientas en el entorno familiar y escolar maximizan sus beneficios, sugiriendo que la inteligencia artificial tiene el potencial de transformar significativamente la educación especial.

**Palabras clave:** inteligencia artificial; aplicaciones; educación; TEA; niños

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**Fecha de recepción:** 21/agosto/2024 | **Fecha de aceptación:** 03/septiembre/2024 | **Fecha de publicación:** 22/septiembre/2025

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## INTRODUCTION

ASD is a neurological and developmental condition that significantly affects social interaction, communication and behavior, appearing at an early age and persisting throughout life, while presenting a wide variety of symptoms and severity levels. Children with ASD may experience difficulties communicating verbally and nonverbally, understanding and responding to social cues, and developing playing skills and other activities, since the diverse ways in which ASD shows make each individual unique, requiring personalized educational and care approaches (Cabezas & Oses, 2024).

The educational process for children with ASD poses several challenges, since traditional teaching methods, which are usually linear and unadaptive, do not always meet the specific needs of these children. Difficulties in communication and social interaction may limit their ability to fully participate in conventional educational settings; also, sensory issues and inflexibility in thought and behavioral patterns may interfere with learning and adapting to new situations (Isisqui et al. 2023). Context and families of children with ASD are constantly searching for tools and strategies to support development of skills and facilitate effective learning; in this context, technology, and more specifically: AI-backed virtual applications, have emerged as a promising solution to address these needs (Cordero, 2023).

In the current digital age, where technology plays a significant role in almost every aspect of life,

education is no exception. Digital technologies have transformed teaching and learning methods, offering new opportunities to personalize and enhance the educational experience; Among these technologies, AI-backed virtual applications have gathered special attention due to their ability to tailor educational content to the individual needs of students (Martínez, 2022).

AI refers to the ability of machines to perform tasks that typically require human intelligence, such as learning, reasoning, and decision-making. In the educational context, AI can analyze substantial amounts of data to find patterns and tailor content and teaching strategies to each student's specific needs. This is particularly useful for children with ASD, who require personalized approaches to learning and development (Cortez et al., 2024).

Virtual AI applications designed for children with ASD offer a variety of benefits. as these tools can provide a personalized learning experience, adapting to each child's skills and preferences, also including interactive activities that encourage social skills development, communication and adaptive behavior; in addition, they are used in a variety of environments, including home and school, facilitating continuous integration of learning into the child's daily life (Camargo & Fonseca, 2024).

One of the main benefits of AI-enabled virtual applications is their ability to provide real-time feedback. so that children receive immediate guidance and correction, which is crucial to your

learning, in addition, These applications can use gamification techniques to keep children motivated and engaged in the learning process, involving the use of game design elements in non-playful contexts, creating a more engaging and fun learning experience (Cruz et al. 2023). Another meaningful benefit is the ability of these applications to track the child's progress over time, AI can analyze usage and performance data to identify areas of strength and weakness, providing valuable information to educators and parents, enabling tuning of instructional strategies and better supporting the child's development (Rodríguez et al., 2023).

While virtual applications with AI offer numerous benefits, they also present challenges, one of the main ones is to ensure that these tools are accessible and usable for all children with ASD, regardless of their level of technological ability or device access, and it is crucial to ensure that applications are secure and protect the privacy of user data (Sánchez, 2023). It is also important to consider the role of educators and parents in the use of these technologies, although applications can provide meaningful support, they cannot replace the need for human interaction nor the fundamental role of educators and parents in child development, best practices involve the use of virtual applications as a complementary tool in a comprehensive educational approach (Ronquillo et al., 2023).

AI-backed virtual applications are a significant innovation in education for children with ASD. These tools offer the ability to personalize learning,

provide real-time feedback, and keep children motivated through gamification techniques (Coicaud, 2020). While there are challenges in their implementation, the potential benefits for skill development and improving the quality of life of children with ASD are immense, hence continuing the research and development of these technologies will be critical to maximize their positive impact and ensuring that all children have the opportunity to reach their full educational potential (Camargo & Fonseca, 2024).

Based on the above, the purpose of this article is to explore how virtual applications with artificial intelligence benefit children with ASD in the educational field and how they transform their learning experience; These apps focus on improving the expression and understanding of emotions, which is fundamental to social interaction, through interactive games, teach children how to differentiate and recognize emotions through images of real people, showing when and how they manifest themselves.

## **METHODS, TECHNIQUES, AND INSTRUMENTS**

This section details the methodology used to meet the research objectives through documental analysis; this method, according to Bermeo et al. (2016), involves a number of specific processes including the search, selection, organization and analysis of relevant documents; Tobón et al. (2015) emphasize that this process focuses on answering specific questions on a particular topic. The main goal of this

method is to relate the existing data on a given construct, offering a comprehensive view that eases the formulation of adequate solutions to the problem posed (Rivera et al., 2018).

This work examines articles that explore and evaluate the use of AI-enabled virtual applications in learning children with ASD. To achieve this objective, recent studies, published from 2020 to the present, were reviewed and synthesized through a rigorous selection, evaluating the effectiveness and benefits of these technological tools; additionally, the difficulties that children with ASD face in traditional education and how virtual applications with AI adapt to these specific needs were identified.

A comprehensive search was conducted in academic databases such as Google Scholar, PubMed, Scopus and other scientific repositories, including search terms with keyword combinations such as "artificial intelligence", "virtual applications", "autism spectrum disorder", and "special education". Results were filtered, to limit them to studies published between 2020 and 2024. Once the selected documents were collected, they were organized according to their relevance and subject matter, categorized based on the aspects they address, such as application effectiveness, educational challenges, and adaptation strategies.

Subsequently, a critical analysis of the selected studies was conducted, evaluating the method, results and conclusions of each one, paying special attention to the quality of research designs, the validity of the data

and the consistency of the conclusions. Findings from the reviewed studies were synthesized to provide an overview of the impact of AI-based virtual applications in the learning of children with ASD, highlighting the benefits seen as areas requiring further research.

## RESULTS AND DISCUSSION

According to the literature review conducted, the use of AI-backed virtual applications has revolutionized the field of special education, offering new opportunities for learning and skills development in children with ASD. Recent studies have underscored the effectiveness of these technologies not only in academics, but also in the development of social and communication skills, crucial for the educational and social inclusion of these children. This analysis presents the similarities and findings of different research on the effectiveness of AI applications in this context (Table 1).

The growing integration of technology tools into education has made a significant impact on training and skill development, especially in inclusive education settings. A systematic review by Meza & Mendoza (2023) stresses that, without quality education for everyone, it is impossible to form a society of knowledge; the authors emphasize the need to employ technologies that improve their skills and abilities, giving both educators and students autonomy with responsibility by promoting meaningful learning.

**Table 1.** *Main Studies on Artificial Intelligence and Education for Children with ASD*

Author	Concept	Similarities
García & López (2021)	Artificial intelligence-based educational technologies play a crucial role in improving learning in children with ASD.	Applications improve the learning process.
Martínez & Pérez (2021)	Addresses the challenges and applications of artificial intelligence in special education, highlighting its potential to personalize learning strategies in children with autism.	Highlights the potential of AI applications
Muñoz & Hernández (2021)	They evaluated a virtual reality application for social skills development in children with ASD, finding positive and meaningful results.	Applications are making positive progress in special education.
Sánchez & Gómez (2021)	They evaluated new mobile applications for educational intervention in children with autism, highlighting their effectiveness in improving communication and social skills.	They question the effectiveness of these applications in learning and how it improves social interaction and communication.
Ruiz & Fernández (2022)	They found that these tools can have a positive impact on social skills development in children with ASD, promoting greater interaction and communication.	Help children with ASD have better social and communicative interaction.
Torres & Fernández (2022)	They researched the use of artificial intelligence applications in the communication of children with ASD, finding that these tools can provide significant support in the development of communication skills.	Provides meaningful support for methods to personalize special education.
Martínez & Torres (2023)	They explored the potential of artificial intelligence and adaptive learning in the education of children with ASD, highlighting their ability to adjust educational activities to each child's individual needs.	This adjustment of customized methods helps everyone to feel comfortable

Source: Self-preparation (2025)

Rodríguez & Alvarez (2020) presented a case study on the use of AI to customize learning in children with ASD. This study looked into how AI-enabled applications can be tailored to the individual needs of each user: the developed programs customized learning to each child's pace and methods of study, resulting in significant improvements in academic performance, increased motivation and engagement, and ease social interaction regarding communication; these findings highlight the potential of AI as an inclusive and effective tool in education.

A study by Soledispa et al. (2024) mentions that AI is a valuable help for education; however, it also raises challenges and concerns related to dehumanizing the educational process and ethical issues on privacy. Addressing these issues is crucial to ensuring an ethical and fair implementation of AI in education,

guaranteeing that technology tools help all students without compromising their well-being and privacy.

Navarre & Sanchez (2022) reviewed the recent impact of digital technologies on children with ASD learning; their analysis included studies and projects implemented in recent years, highlighting how tools, such as mobile apps, augmented reality and artificial intelligence, have been used to improve different skills in these children. Improvements include communication, social interaction, and academic learning, showing the broad potential of these technologies in inclusive education.

Vazquez & Medina (2023) noted that using apps eases teaching abstract concepts and improves social interaction through simulated scenarios; these apps allow children to interact in a controlled and secure space, helping them reduce anxiety and increase confidence in real-world situations. This approach not only enhances academic skills, but it also provides a safe environment to practice and develop essential social skills.

## CONCLUSIONS

The integration of AI-backed virtual applications into the education of children with ASD has proven to be a revolutionary tool with highly promising results, showing that these emerging technologies have a significant impact on various aspects of learning and skills development in this specific population. Through a personalized and adaptive approach, AI-enabled applications have the potential to accurately respond to each student's individual needs, helping

both academic performance and the development of social skills, crucial to educational inclusion.

AI-based applications enable an unprecedented customization of the educational process; unlike traditional methods, which often take a uniform and rigid approach, these tools tailor content and pedagogical strategies to each child's unique characteristics and needs, allowing this individualized approach to be especially beneficial to children with ASD, who can present a wide range of skills and challenges. AI-enabled applications adjust activities and resources in a dynamic way, providing each student with an optimized learning experience aligned with their pace and learning style.

In addition to improving their academic performance, these technologies also play a crucial role in the development of social and communication skills, a difficulty often faced by children with ASD in social interaction, effective and affective communication; these applications include

interactive tools designed to address these specific areas, offering simulated scenarios and exercises that facilitate the learning of essential social skills. Through games and activities designed to improve emotional understanding and communication skills, these applications not only support academic learning, but also encourage social and emotional integration.

As a group, the reviewed studies highlight the transformative potential of technology in inclusive education, the ability of AI-enabled applications to customize and adapt learning offers a unique opportunity to improve educational quality and foster the comprehensive development of children with ASD. However, in order to maximize these benefits and ensure its effective application, it is crucial to continue researching and refining these methods, since constant evaluation and innovation in the use of educational technologies will allow facing emerging challenges and enhance the positive impact on the development of all students

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## Analysis and interpretation of data in medical research

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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.

Nowadays, quantification is essential for data to be applied appropriately and conveniently. Experts agree that a clinician or medical researcher who is not able to numerically express results or conclusions will not provide reliable information. In other words, statistics as a quantitative analysis tool is, in this case, at the service of medicine.

This statement may seem exaggerated, but the reality is that the medical information we review within our fields of competence today bears the stamp of evidence-based medicine, where the critical analysis of the literature focuses on statistical and methodological aspects for diagnostic, prognostic, pharmacological, non-pharmacological and preventive decision making. David Sackett and Gordon Guyatt, both academics at McMaster University in Ontario, Canada, noticed as early as the 1970s how inaccessible it was for clinicians to read the enormous amount of information being generated; it was necessary to establish practical, critical and relatively agile strategies for scientific reading.

To this end, they deemed it appropriate to train professionals and provide them with knowledge in research methodology and biostatistics; therefore, in the 1990s David Sackett together with clinical epidemiologists from that university, began a series of guide-articles in the U.S. journal JAMA about the critical appraisal of medical literature. It goes without saying how successful their work was. It is worth having the full series of those publications. We recommend searching for and reading them.

Over time the need to practice agile and dynamic reading not only persists, but has increased exponentially. The evidence is overwhelming: it is imperative to know how to read a scientific paper in order to evaluate the best options for the benefit of patients. Of course this is for medical purposes; but what if we do not only want to be receivers of knowledge, but also aspire to be generators of new knowledge? In that case we will equally need statistical and methodological competencies.

As mentioned in the first booklet, some procedures will be reviewed to master the appropriate use of statistical tools, as well as to know and understand when and how to use a given method that allows interpretation of information and making the best decisions. In this second issue we present material with three objectives:

1. First, to expose a taxonomy of statistics that is simple and practical to understand, adhering to the principle of parsimony.
2. Second, to conceptualize and contextualize each of the elements that make up the taxonomy. A more integrative and detailed breakdown will be provided in subsequent booklets.
3. Finally, to present a glossary of symbols that is commonly found in mathematics in general and statistics in particular.

### TAXONOMY IN STATISTICS

A taxonomy is an organized classification system that groups and categorizes elements based on common characteristics. It is often considered synonymous with classification, but for the purposes of this project the term taxonomy will be used. The term comes from ancient Greek: (taxis, "ordering") and (nomos, "norm" or "rule"). It is a procedure applied in science in general as well as in other fields of knowledge. The ultimate purpose, wherever required, is to organize and understand information. Taking these considerations into account, statistics is no exception.

For a taxonomy to be effective it must be clear, simple, relevant and compatible with norms or standards, because that way it will ensure efficient use of information. Reviewing the literature and contrary to what might be thought, a single taxonomy in statistics does not exist.

On the contrary, there are diverse proposals and often statistical aspects are mixed with topics related to research methodology. Of course these elements are complementary in scientific research, so it is really difficult to separate them. But the idea on this occasion is to try.

It is not the primary objective of this booklet to propose new classifications or something atypical; the suggestion is simply an organization that addresses exclusively the statistical theme. The intention in this document was to adhere to the principle of parsimony, which states that under equal conditions the simplest explanation is usually the best and most convenient.

Taking into account the intrinsic characteristics of the elements indicated in this taxonomy, an attempt was made for it to be exhaustive and mutually exclusive, that is, to leave no element outside the formed groups and that those elements belonged only to one group. Based on the above, the following is presented: STATISTICS (main branches)

- DESCRIPTIVE
- INFERENTIAL
- PARAMETRIC
- NON-PARAMETRIC

## **DESCRIPTIVE STATISTICS. CONCEPTS AND GENERALITIES**

Descriptive statistics is a key piece of data analysis. As the name implies, its objective is to describe and summarize the characteristics of the information provided so that it is easy to understand. This strategy does not aim to make inferences or draw aggregated conclusions.

This type of analysis involves the computation and presentation of various statistical measures, such as the mean, median, mode, standard deviation, variance and percentiles, which provide valuable information about central tendencies, dispersion and the overall distribution of data. Another main objective of descriptive statistics is to communicate as much information as possible in the simplest and most efficient way.

By presenting these summarized measures, readers can obtain a clear picture of the data, including typical values, the degree of variability, and any possible outliers or skewness in a sample or a population.

Its use extends to several fields, including data science, where it plays a crucial role in the initial exploration and understanding of data. In the context of medical research, it is used to summarize participant characteristics such as age, race, gender, social stratum and disease prevalence, to name a few examples.

By understanding this information, informed decisions can be made to perform further analyses and hypothesis testing with more advanced statistical methods, which will lead to more reliable conclusions.

Descriptive statistics has the advantage of representing obtained data in bar charts, histograms, scatter plots or line charts, among other methods, which further facilitates understanding of the information.

We can summarize, then, that the objectives of this statistical strategy are:

- Collect data
- Organize information
- Present and tabulate data
- Analyze results

## **INFERENTIAL STATISTICS. CONCEPTS AND GENERALITIES**

Inferential statistics is a branch of statistics that allows generalizations to be made and informed decisions to be taken based on representative samples from a particular population. The condition is that the study samples are obtained from the target population through calculation, and that the study units have been selected randomly.

Unlike descriptive statistics, which focuses on ordering and describing collected data, inferential statistics uses these data as a basis for making predictions or inferences, that is, generalizations. One of the fundamental pillars of inferential statistics is the concept of probability, which provides a framework for quantifying uncertainty; this is essential because no datum is necessarily definitive — there will always be circumstances that generate errors.

Topics such as confidence intervals, parameter estimation and hypothesis testing are key elements that make it possible to quantify results and make predictions with greater certainty for entire populations from selected samples. In any case, when the sample is selected through randomization, any conclusion will be subject to a margin of error, which must be considered beforehand.

Hypothesis testing is a central procedure in inferential statistics used to determine whether there is sufficient evidence in a sample of data to infer that a certain condition is true for the whole population. This process involves formulating a null hypothesis and an alternative (research) hypothesis, and then using statistical methods to determine which of these hypotheses is more consistent with the collected data.

Confidence intervals, on the other hand, should ideally accompany the quantification of statistical parameters (measures of central tendency and dispersion) and population parameters (rates, indices, prevalence, incidence, odds ratios, relative risk, etc.), as they assess the margin of error associated with the calculation.

A 95% confidence interval, for example, suggests that if sampling were repeated many times, in 95% of the calculations the intervals obtained would contain the true population parameter. This methodology is crucial since, in the real world, because it is impracticable to approach complete data for an entire population, obtaining study samples and making inferences is more the rule than the exception. Inferential statistics is also applied in medicine — for example, it is used to evaluate the effectiveness of new treatments or medications.

It is crucial to bear in mind that inferential statistics is not free of limitations: inadequate sampling can lead to bias and, consequently, to incorrect inferences. Moreover, incorrect interpretation of statistical results can lead to erroneous conclusions and poor clinical decisions.

In summary, inferential statistics is a powerful tool that allows limited data to be turned into applicable knowledge to understand and improve the world around us. Through hypothesis formulation, probability calculation and constructing confidence intervals, it provides a robust framework for decision-making under uncertainty. However, its effective application requires a deep understanding of its methods and limitations to avoid errors and maximize its potential.

## **PARAMETRIC STATISTICS. CONCEPTS AND GENERALITIES**

Parametric statistics is a fundamental branch of inferential statistics that focuses on the analysis of data where the data must satisfy certain rules or assumptions (as they are called) for the results to be reliable and valid. This is basic because the use of parametric statistical tools guarantees a more robust and precise analysis of the data under study. In other words, statistical tests called "parametric" are based on a set of parameters that must be met without question.

One of the central aspects of parametric statistics is the use of well-known distributions, such as the normal, binomial and Poisson distributions, which can be represented using tables, graphs or mathematical functions. In the case of the normal distribution, which is perhaps the best known, we must understand the concept as a theoretical model in which the values of a variable or set of variables under study are symmetrically distributed around a central value.

The distribution is characterized by a bell shape; it is described mathematically and depends on two parameters: the mean and the standard deviation. These distributions allow calculations to be simplified and conclusions to be obtained more quickly, provided that the data adequately fit the assumptions of the model.

The normal distribution is the basis for numerous parametric methods due to its prevalence in nature and its relationship with the central limit theorem. This theorem states that if many samples are taken from a population — for example, the height of people — and you calculate the mean of each sample, as the number of samples increases the distribution of those sample means will approach a normal curve, regardless of how the original data themselves were distributed. In other words, the larger the sample size, the closer the distribution of the means will approximate a normal distribution.

The use of parametric methods comes with several advantages: first, when the rules or assumptions for their use are met, these methods tend to be very efficient, providing precise and powerful estimates with smaller sample sizes compared to their nonparametric counterparts. Furthermore, because of the mathematical structure of parametric models, extensive analyses are facilitated that allow a deeper and more rigorous understanding of the data. However, parametric statistics is not without limitations: the main drawback lies in the dependence on assumptions about the distribution of the data. If these assumptions are not met, results may be incorrect; therefore, it is crucial to verify the distribution prior to application.

Thus, in situations where it cannot be guaranteed that the data follow a specific distribution, nonparametric methods may be more appropriate, albeit at the cost of lower efficiency. Among the most common techniques

used in parametric statistics are hypothesis tests, confidence interval estimation and analytic regression models, among others. Hypothesis testing, where statistics such as Student's t and analysis of variance (ANOVA) can be used, allow the determination of the significance of results based on specific parameters such as the population mean or variance.

Confidence intervals, in turn, provide a plausible range for unknown parameters, offering crucial information about their precision and reliability. Regression models are a powerful tool to model, among other things, the relationship between variables and to make predictions. In conclusion, parametric statistics constitute an essential tool in data analysis, equipped with efficient and powerful methods to investigate and understand natural and scientific phenomena. Although the greatest emphasis is placed on the normality of the distribution, there are other considerations that must be taken into account.

Common assumptions for many parametric methods include:

- Normality in the distribution of the data
- Homogeneity of variances (also called homoscedasticity)
- Independence among observations
- Linearity in the case of regression models
- Variables should be measured on an interval or ratio scale.

### **NON-PARAMETRIC STATISTICS. CONCEPTS AND GENERALITIES**

Non-parametric statistics has become an invaluable tool in data analysis, especially in situations where the traditional assumptions outlined above cannot be confirmed, making it more versatile and applicable in a variety of real-world scenarios. It is important to understand that what distinguishes non-parametric statistics from its parametric counterpart is that it does not rely on specific parameters (such as the mean and standard deviation) nor does it assume a normal distribution of the data. This matters because in practice the assumptions are not always met.

Major non-parametric techniques include rank tests such as the Wilcoxon signed-rank test, the Mann–Whitney U test, and the Kruskal–Wallis H test. These tests compare medians or ranks instead of means, which makes them more robust in cases of skewed data or outliers. For example, when comparing the effectiveness of two medical treatments, data may not be normally distributed due to variability in patients' responses. In such cases a non-parametric test can provide more reliable results. The flexibility of non-parametric statistics also extends to its ability to handle different types of data, including ordinal and categorical data.

Often in social and psychological research, data are collected on ordinal scales, for example those that measure patient satisfaction on a scale from "very dissatisfied" to "very satisfied". Non-parametric methods can analyze these data without needing to convert them into a numerical scale, thereby preserving the integrity of the original measurement. A critical aspect of non-parametric techniques is their interpretative simplicity: by not depending on complex assumptions about the distribution, the results can be easier to interpret and communicate to a non-technical audience. This is particularly beneficial in interdisciplinary contexts where clarity and accessibility of results are essential.

Despite their many advantages, non-parametric methods often require larger samples to achieve acceptable statistical power; additionally, some non-parametric methods can pose challenges for very large datasets. In conclusion, non-parametric statistics offer a powerful and flexible alternative to traditional parametric methods. Their ability to analyze data without strict distributional assumptions makes them especially useful in disciplines with varied and hard-to-model data. Although they may be less efficient in terms of sample size, their applicability and ease of interpretation often make them the preferred choice in real-world studies where ideal conditions are rarely found.

**GLOSSARY OF SYMBOLS**

Sample standard deviation	S
Population standard deviation	$\sigma$
Sample variance	$S^2$
Population variance	$\sigma^2$
Population mean	$\mu$
Sample mean	$\bar{x}$
Median	Md
Mode	Mo
Absolute frequency	fai
Cumulative absolute frequency	Fai
Relative frequency	fri
Cumulative relative frequency	Fri
Frequency of a score or category	f
Degrees of freedom	gl
Alternative hypothesis	H1
Null hypothesis	Ho
Significance level	$\alpha$
Population size	N
Sample size	n
Summation operator	$\Sigma$
Probability of committing Type II error	$\beta$
Probability of committing Type I error	$\alpha$
Probability (also sometimes represents significance level)	q
Proportion	P
Analysis of variance (ANOVA)	F
Z-score	z
Chi-squared	$X^2$
Spearman correlation coefficient	rho
Pearson correlation coefficient	r
Kruskal–Wallis test	H
Wilcoxon signed-rank test	T
Cochran's Q test	Q
Student's t-test	t
Mann–Whitney U test	U
Proportion	P
Cramér's V coefficient	C
Kappa statistic	K
i-th value of a variable	$X_i$
Maximum value of a variable	$X_{max}$
Minimum value of a variable	$X_{min}$
Variable to compute	x

Upper limit of an interval	Ls
Lower limit of an interval	Li
Width (amplitude) of an interval	a
Class mark (class midpoint)	X
Random error or residual in linear regression	$\epsilon$

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## Advances and challenges in medical education: An interdisciplinary approach

Porrúa Print-Librería de Porrúa hermanos y compañía S.A. de C.V. ISBN 978-607-515-536-4

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### SUMMARY

Given the diversity of changes made in basic education in recent years, the training of students has been so uncertain that it is difficult for us to figure out their exit profile. Between the updates in the Educational Reform of 2013 and the “Nueva Escuela Mexicana” (New Mexican School Reform), whose plans were ratified by the Legislative Power in 2019, the entry profiles of students from the various universities of the country have been “affected,” so to speak, and if we add the consequences of the COVID-19 pandemic, having access to literature such as the one presented above is a true oasis in the desert.

Finding institutions that take the time to observe and analyze the behavior of their educational community before and after the pandemic and go beyond that, by finding areas of opportunity and work upon them, is something worth emulating.

**Keywords:** pandemic, resiliency, virtual learning, area of opportunity.

As a teacher and researcher, I greatly appreciate the authors of the work *Advances and Challenges in Medical Education: An interdisciplinary approach*, since they present us with research results in each chapter that might seem very basic, but that are definitely the core to diagnose the needs of university students. Details that help us to find their areas of opportunity, to educate comprehensively and with excellence, according to the standards of the alma mater where these researchers work, the School of Medicine of the Universidad Autónoma de Tamaulipas, Southern Region.

Aimed at researchers, academics, teachers, as well as students, all can benefit from information and/or find the needed empathy to both strengthen their area of opportunity and name their strengths. Chapter 1 involves two research studies for those who study the degree for Surgeon Physician: “Learning Styles and Their Relationship to Academic Performance in Students of Medical Surgeon Degree” and “Stress Profile and Coping Styles in Students of the Medical Surgeon Degree,” closing the chapter with the “Advantages of the Peer-to-Peer Use of Generative Artificial Intelligence in Undergraduate Medicine Teaching: A Systematic Review”.

Chapter 2 is focused on “Attitudes of the Social Service Medicine Interns: Use of Telemedicine”, “Mental Health Effects Related to Covid-19 Lockdown in Medical Students” which, upon reading, makes me reflect not only on students at said school, but on all students regardless of educational level. They close the chapter with “Resilient Factors in Students of the Medicine Degree at the Universidad Autónoma de Tamaulipas.” The sum of the elements considered makes the academic and administrative body of the institution worthy of recognition, as it proves a real concern for its student community. This is a praise-worthy detail that all institutions should consider: how the pandemic affected our students, what improvements were made and what areas of opportunity were found for teachers, schools, system or government, as well as the families.

They complete the work with Chapter 3, where they consider “Culture of Digital Literacy in College Students,” “The Impact of Virtual Modality on the Quality of Learning for Students in the Area of Health Sciences” and “The Virtual Learning Environments as a Support Tool in the Teaching – Learning process”; those of us who teach know that these are topics, that emerged during the pandemic but stayed with us, have been challenging not only for digital migrants (Generation X’ers), but also for those part of the Generation Y or Millennials, as well as Z, to which current college students belong, an even for Generation Alpha, to which current the basic education students belong.

With 40 years as a Basic Education teacher in the state of Sonora and just over 20 years in research and involvement with Middle and Higher education in several states of the country, I am extremely pleased to find this kind of bibliographical support, so varied and assertive, hence I praise the authors in addition to widely recommend its reading.

This book not only articulates the ongoing commitment of the Cuerpo Académico (Research Group) UAT-CA-180, “ICT, Education and Health”, with academic excellence and interdisciplinary research, but also strengthens its mission to disseminate knowledge and promote the comprehensive development in the critical areas of education, health and technology. This is a priceless resource for academics, students, and professionals interested in studying the complex challenges and opportunities that define the progress of medicine and Medical Education.



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