



## UNIVERSITY DIDACTIC 4.0 FOR PROFESSIONALS OF THE 21ST CENTURY

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### ABSTRACT

**Objective:** This study investigates the impact of transitioning towards "University 4.0" on shaping professionals capable of addressing the 21st-century challenges. It highlights the integration of advanced technologies and innovative pedagogical approaches in higher education.

**Theoretical Framework:** The study focuses on the necessity for higher education to adapt to advanced methodologies and technologies to meet the demands of the knowledge society and the digital economy. It emphasizes the importance of ICT in educational transformation and the evolution of the teacher's role towards a learning facilitator.

**Method:** Descriptive analysis based on bibliographic review and surveys conducted with students and teachers, exploring emerging pedagogical practices and the integration of telelearning resources and ICT in educational environments.

**Results and Discussion:** A significant transformation towards more interactive and student-centered learning is revealed. The advantages of digital technologies in teaching and the challenges related to accessibility and equity are discussed.

**Research Implications:** Suggests the need for a holistic approach that integrates technical, cognitive, and social competencies to properly prepare future professionals. It underlines the importance of overcoming technological and pedagogical barriers for a more inclusive and effective education.

**Originality/Value:** Provides a comprehensive perspective on the evolution of university didactics towards education 4.0, emphasizing the need to adapt to technological and sociocultural changes to form competent and versatile professionals in the global and technologically advanced context of the 21st century.

**Keywords:** Education 4.0, Advanced Technologies, Innovative Methodologies, Professional Competencies, Interactive Learning.

## DIDÁTICA UNIVERSITÁRIA 4.0 PARA PROFISSIONAIS DO SÉCULO XXI

### RESUMO

**Objetivo:** Investigar o impacto da transição para a "Universidade 4.0" na formação de profissionais capazes de enfrentar os desafios do século XXI, destacando a integração de tecnologias avançadas e abordagens pedagógicas inovadoras no ensino superior.

**Marco Teórico:** Concentra-se na necessidade de adaptação do ensino superior às metodologias e tecnologias avançadas para atender às demandas da sociedade do conhecimento e da economia digital. Destaca a importância das TIC na transformação educativa e a evolução do papel do docente para um facilitador da aprendizagem.

**Método:** Análise descritiva baseada na revisão bibliográfica e em pesquisas com estudantes e professores, explorando as práticas pedagógicas emergentes e a integração de recursos de teleaprendizagem e TIC nos ambientes educacionais.

**Resultados e Discussão:** Revela uma transformação significativa para uma aprendizagem mais interativa e centrada no aluno. Discute-se as vantagens das tecnologias digitais no ensino e as dificuldades relacionadas com a acessibilidade e equidade.

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**Implicações da Pesquisa:** Propõe a necessidade de uma abordagem holística que integre competências técnicas, cognitivas e sociais para preparar adequadamente os profissionais do futuro. Enfatiza a importância de superar barreiras tecnológicas e pedagógicas para uma educação mais inclusiva e eficaz.

**Originalidade/Valor:** Oferece uma perspectiva integral sobre a evolução da didática universitária em direção à educação 4.0, destacando a necessidade de se adaptar às mudanças tecnológicas e socioculturais para formar profissionais competentes e versáteis no contexto global e tecnologicamente avançado do século XXI.

**Palavras-chave:** Educação 4.0, Tecnologias Avançadas, Metodologias Inovadoras, Competências Profissionais, Aprendizagem Interativa.

## LA DIDÁCTICA UNIVERSITARIA 4.0 PARA PROFESIONALES DEL SIGLO XXI

### RESUMEN

**Objetivo:** Investigar el impacto de la transición hacia la "Universitaria 4.0" en la formación de profesionales capaces de afrontar los desafíos del siglo XXI, resaltando la integración de tecnologías avanzadas y enfoques pedagógicos innovadores en la educación superior.

**Marco Teórico:** Se enfoca en la necesidad de adaptación de la educación superior a las metodologías y tecnologías avanzadas para cumplir con las demandas de la sociedad del conocimiento y la economía digital. Destaca la importancia de las TIC en la transformación educativa y la evolución del papel del docente hacia un facilitador del aprendizaje.

**Método:** Análisis descriptivo basado en la revisión bibliográfica y encuestas a estudiantes y docentes, explorando las prácticas pedagógicas emergentes y la integración de recursos de teleaprendizaje y TIC en los entornos educativos.

**Resultados y Discusión:** Revela una transformación significativa hacia un aprendizaje más interactivo y centrado en el estudiante. Se discuten las ventajas de las tecnologías digitales en la enseñanza y las dificultades relacionadas con la accesibilidad y la equidad.

**Implicaciones de la Investigación:** Propone la necesidad de un enfoque holístico que integre competencias técnicas, cognitivas y sociales para preparar adecuadamente a los profesionales del futuro. Subraya la importancia de superar barreras tecnológicas y pedagógicas para una educación más inclusiva y efectiva.

**Originalidad/Valor:** Ofrece una perspectiva integral sobre la evolución de la didáctica universitaria hacia la educación 4.0, destacando la necesidad de adaptarse a los cambios tecnológicos y socioculturales para formar profesionales competentes y versátiles en el contexto global y tecnológicamente avanzado del siglo XXI.

**Palabras clave:** Educación 4.0, Tecnologías Avanzadas, Metodologías Innovadoras, Competencias Profesionales, Aprendizaje Interactivo.

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## 1 INTRODUCTION

The evolution towards "University 4.0" represents a momentous change in education, highlighting the need to integrate advanced methodologies and technologies to train professionals prepared for the challenges of the 21st century. This approach promotes dynamic, interdisciplinary and hands-on learning, which is essential for the digital economy and the knowledge society.



In this context, computer science and technological innovations, such as simulators and digital learning tools, become essential components of the educational process. According to Basco et al. (2022), the transition to Industry 4.0 requires a parallel educational reform that prepares students for highly technological and automated work environments. This transformation involves not only the acquisition of technical skills but also the development of analytical and problem-solving skills, fundamental in the information age.

ICTs have significantly reshaped higher education, providing new learning environments that foster the development of skills crucial to life and work. As Choudhari (2017) points out, familiarity and competence with these technologies from an early age is vital, as ICTs have been fully integrated into the personal and social lives of new generations. Educational institutions should therefore ensure that all students have access to these tools on an equitable basis, which poses challenges of accessibility and equity.

The shift in the role of the teacher from a knowledge transmitter to a learning facilitator aligns with contemporary pedagogical theories that favor a more student-centered approach. This approach is supported by research by Chouhan and Dubey (2019), which emphasizes the importance of adapting educational technologies to improve learning efficiency and interactivity, allowing students to actively participate in building their knowledge.

However, education 4.0 also involves overcoming the limitations of traditional teaching methods, which often focus on memorization and repetition rather than deep understanding and practical application. Balta et al. (2023) highlight how innovations in data estimation and analysis, such as in the field of water quality, can be applied to improve the contextualization and visualization of complex concepts in education.

The relevance of integrating technological resources in teaching is echoed in the studies of Gul, Memon, and Naz (2018), which investigate the applications of information technologies in fields such as remote sensing. The adaptation of these technologies to education allows not only a greater understanding and retention of information by students, but also a greater preparation for future professional demands.

The "University 4.0" requires a profound reassessment of pedagogical strategies to align with the needs of a globalized and technologically advanced world. Beck's (2022) research in public health, while seemingly distant, underscores the importance of evidence-based training and the need to adapt education to global realities and cross-cutting challenges.

Therefore, the transition towards more technologically integrated and learner-centered higher education is essential to train competent and versatile professionals in the 21st century. This transformation, supported by research in a variety of fields, from engineering to public



health, requires a holistic approach that addresses both technical skills and cognitive and social competencies, thereby ensuring that higher education remains relevant and effective in training future leaders and professionals.

## 2 OBJECTIVES

The objective of this research is to examine how the transition towards "University 4.0" impacts the training of professionals fit to face the challenges of the 21st century. It seeks to understand how the integration of advanced technologies and innovative pedagogical approaches, as reflected in the studies of Singh and Singh Tomar (2023), Sousa et al. (2022), S and Sreenath (2022), Waheeb (2022), and Zyadat (2023), can improve educational environments and develop key competencies in students.

This study proposes to evaluate the influence of ICT in higher education, highlighting the need for accessibility and adaptability, based on the contributions of current research in fields such as the Internet of Things (IoT) and technologies related to network security and efficiency. It also considers the importance of preparing students with practical knowledge for complex problem solving and crisis management, a need underscored by innovation in applications and sustainability in business practices.

The ultimate aim is to validate the integration of these technologies and pedagogical methods into university training, ensuring that future professionals are equipped with the skills and knowledge necessary to thrive in a global and technologically advanced environment.

## 3 JUSTIFICATION

In the current context, marked by the COVID-19 pandemic, education systems at a global level, including Costa Rica, face the challenge of effectively integrating information and communication technologies (ICT) to provide students with the necessary tools and knowledge to adapt to this new reality. This situation has accelerated the transition from a teacher-centered educational model to a more student-centered approach, promoting interactive and accessible learning environments. Within this framework, access to educational materials becomes a fundamental pillar for the exercise of the right to education and the effective functioning of the system at all academic levels.

Acuña Acuña (2023) highlights the importance of data mining and the Internet of Things (IoT) in education, suggesting that these technologies can facilitate adaptation to virtual



environments and improve teaching and learning processes. Research by Adebayo et al. (2022) on blockchain technology highlights its potential to address security challenges in IoT, a critical aspect of ensuring a safe and reliable online educational environment.

The need to overcome space-time barriers has become more evident, allowing individuals from anywhere to access educational content at any time, provided they have the necessary technology. This underlines the importance of the flexibility and adaptability of virtual learning environments, as pointed out by Arshad et al. (2021), which investigate hybrid machine learning techniques applicable to the detection of human activities, relevant for the design of interactive educational platforms.

The concept of virtual community is especially relevant, as evidenced by Barraza and De Jesús (2019) in their cybersecurity implementation model for IoT systems in 5G networks, providing a framework to create safe and efficient virtual spaces for interaction and learning. This new virtual environment promotes interaction among all members of the educational community, facilitating the resolution of academic and administrative problems in a collaborative environment.

However, the shift towards virtualization of education poses challenges, such as keeping students engaged and belonging remotely. This is where the contributions of Balta et al. (2023) are relevant, as their review on water quality estimation and anomaly detection can be paralleled with the need for innovative teaching materials that promote autonomous and meaningful learning.

Teachers require training and resources to adapt to these new demands. They should be advised on the use of ICTs and on the creation of digital learning content. For students, it is critical to provide access to educational resources through virtual libraries and other digital media, as well as technical support to help them navigate the virtual learning environment.

Finally, educational innovation is presented as an imperative, particularly in times of crisis. Continued adaptation to technological changes and social and labor demands is essential, requiring educators and students to constantly update and be open to change, an aspect highlighted by Amarnadh, Prasad Reddy and Murthy (2018) in their research on image processing and sketch-based recovery.

Therefore, adaptation to a virtual educational environment implies not only overcoming technological and pedagogical challenges, but also the creation of an integrated and secure learning community, where both teachers and students are equipped with the necessary tools to facilitate and enrich the educational process in the context of ICT.



## 4 BACKGROUND

In Costa Rica and globally, the progress in the implementation of new technologies in the educational field has been remarkable. The integration of platforms such as .LRN in the Technological Institute of Costa Rica, mentioned by Eguiluz (2020), exemplifies how information systems can improve services for students, teachers and administrative staff, facilitating a more dynamic learning environment adapted to current needs.

The need to evolve towards the Knowledge Society, described by Valencia (2018), underlines the importance of generating and applying knowledge to shape the future of education. In response, educational programs have been defined that seek to strengthen higher education and adapt it to the digital age, highlighting science, new technologies and teacher training.

However, several challenges are faced, such as the resistance of some educators towards technology, the underutilization of technological classrooms and the limited training in computer tools, which restrict the potential of these programs. These observations, reflected in the experiences of different virtual educational projects in Latin America, reveal the urgency of developing strategies to overcome these barriers.

In this context, relevant studies such as that of Hassija et al. (2019) provide a comprehensive analysis of IoT security, essential for creating secure virtual learning environments. On the other hand, research by Lazarini, Rossi and Hiram (2022) on the accuracy of facial recognition algorithms could improve personalization and interactivity in online education. In addition, the works of Li and Jiunn Deng (2019) and Parra Jiménez emphasize the importance of smart technologies and cybersecurity in the development of innovative education systems.

The implementation of intelligent surveillance systems, as described by Pawar and Lahane (2020), could strengthen the infrastructure of educational institutions, while Ray's (2018) studies on IoT architectures and IoT-based smart systems by Prof. Sathish and Dr. S. Smys (2020) highlight the increasing integration of these technologies in education.

Sai and Pande's (2023) analysis of semantic segmentation of 3D point clouds and Scott's (2016) observations on identity construction can provide valuable insights for the creation of more interactive and personalized educational content. Likewise, Shokoor, Shafik, and Matinkhah's (2022) research on 5G security could offer solutions to address connectivity challenges in distance education.





However, the institutional proposal for an interactive and schooled higher education seeks to respond to the needs of a global and knowledgeable society, promoting the development of new skills and the appropriation of technology. This innovative approach requires an open, collaborative and meaningful education, driven by ICT, to train citizens capable of contributing to social and productive development in the 21st century.

## 5 SCOPE

This study is proposed as a fundamental reference for future research and developments in the field of virtual education in Costa Rica and Latin America, offering a detailed guide for research in the field of Costa Rican and Latin American education. Through a descriptive approach, which Hernández suggests and De Simone proposes, this analysis focuses on detailing the properties and characteristics of educational virtualization, with the aim of mapping the new pedagogical practices that are emerging.

It will examine how telelearning resources affect students in diverse educational contexts, based on the study by Hannan Khan et al. (2019), who analyzed methods to improve security in the Internet of Things, a vital aspect of creating a safe virtual learning environment. In parallel, the contributions of Han Chen and Shiang Cheng (2018) will be considered, exploring the improvement of indoor localization through neural networks, a technology that could optimize virtual learning environments.

The findings of Hassija et al. (2019), which provide a comprehensive perspective on the risks and solutions in IoT security, essential to protect digital educational environments, will also be integrated. Kucukcelebi (2014) brings a different but relevant perspective, focused on water policies, that can inspire transdisciplinary approaches in Costa Rican education.

In addition, the work of Lazarini, Rossi and Hiram (2022) will be analyzed, whose review on facial recognition algorithms can inspire innovative methods to customize and improve interaction in virtual learning environments. Studies by Shukla, Chaurasia and Vishwakarma on the evolution of the IoT will also be included, along with research by Singh and Singh Tomar (2019) on architecture and enabling technologies in IoT, which emphasize the importance of integrating these technologies into education to improve the effectiveness of online learning.

Sousa (2022) and Sreenath (2022) provide concrete examples of how technology can facilitate more interactive and personalized learning, ensuring the adaptability and reliability of the networks that support virtual education systems. These studies provide a solid basis for



understanding how the integration of advanced technologies can transform education, addressing from general perspectives such as the evolution of educational technology to specific aspects such as technical implementation and didactic adaptation in the digital environment.

This project advocates the virtualization of education as a paradigmatic change towards a pedagogical model that responds to the needs of a global and digitally advanced society, promoting autonomous, collaborative and meaningful learning, powered by ICT. In summary, this study is framed in a context of significant educational change, underlining the need for an educational model that incorporates advanced technologies and methodologies adapted to the digital age, in line with the needs and challenges of today's society.

## 6 LIMITATIONS

Within the framework of this research, various limitations related to time and fieldwork have been identified, particularly from the perspective of accessibility. Despite advances in the integration of new technologies in Costa Rica's classrooms, the adaptation of education systems to these new environments and the optimal use of ICT face significant challenges, mainly due to the rapid evolution of these technologies and their widespread adoption by the population.

ICTs hold the promise of improving teaching skills and empowering students to take a more active role in their own learning, providing them with diverse opportunities to research, collaborate and create. However, the effectiveness of this integration depends to a large extent on the willingness and skills of teachers, especially with regard to accessible content design and educational activities (Pawar & Lahane, 2020; P. P. Ray, 2018; Prof. Sathish & Dr. S. Smys, 2020).

The transformation of traditional teaching-learning processes into innovative teaching practices requires overcoming significant obstacles to foster a new educational conception and practice. This means allowing real access to information at any time and from any place, a challenge that is crucial to maintaining continuity and educational quality, especially in crisis situations such as the COVID-19 pandemic.

However, the tools and standards needed to effectively implement ICT in education are already available, although they are not always used to develop accessible content and applications. Only those teachers who are especially committed to the needs of a diverse audience will explore and use the most appropriate tools for inclusive design (Pawar & Lahane, 2020; P. P. Ray, 2018; Prof. Sathish & Dr. S. Smys, 2020).





From the users' perspective, ICT facilitates the exchange of content and allows teaching work to transcend individual or institutional boundaries, contributing to the reduction of the digital divide. However, the situation of teachers and pupils varies considerably from one educational context to another, which can affect the equity and inclusiveness of education.

This work highlights the need for an educational approach that addresses both the opportunities and challenges presented by ICT, promoting practices that are accessible and applicable to a wide range of users, including those with disabilities or with little experience in technology. The adoption of IoT-based intelligent surveillance systems, such as those researched by Pawar and Lahane (2020), together with the understanding of IoT-based intelligent architectures and systems described by Ray (2018) and Prof. Sathish and Dr. S. Smys (2020), can provide valuable lessons for the development of a more inclusive, safe and effective educational environment.

## **7 METHODOLOGICAL FRAMEWORK**

The challenge addressed in this research aligns with the principles of descriptive studies, focusing on a bibliographic research process. This approach employs both quantitative and qualitative data, collected through two questionnaires with both open and closed questions, designed specifically for this study based on the theoretical foundations of the invested class and student engagement. A mixed methodological design was chosen to ensure an amalgam of information sources, which facilitates a more complete and profound interpretation of the results obtained.

To evaluate the experiences of the students, questionnaires were administered at the end of each session, composed of 12 questions on the uncertainty scale, 23 questions focused on telepresence and 9 questions concerning the resources of the learning process. In addition, a survey conducted by the American University aimed to understand the reaction of students during the two weeks of implementation of the virtual teaching model in all courses, addressing the perceived positive and negative aspects, suggestions for the future and the relevance of the content taught for their professional training in the short and long term.

This research method is justified with the support of recent works such as that of Sai and Pande (2023), which provide an analysis of the current progress in the semantic segmentation of 3D point clouds. Although her study focuses on a specific field within technology, she offers valuable insights into how advanced methodologies and technologies can be applied to improve understanding and implementation of innovative educational



practices. This approach allows a rigorous evaluation of contemporary teaching methodologies and their impact on the student learning experience.

## **8 TYPE OF STUDY**

The project focuses on a qualitative research methodology that facilitates collaboration between researchers and programs offered by Latin American Universities. This comprehensive approach includes fact-finding activities designed to capture both qualitative and quantitative data, such as interviews, focus groups and questionnaires, as well as detailed observation activities.

Each proposed activity aims to contribute effectively to the objectives of this research, ensuring a thorough understanding of the phenomena studied. This multidimensional approach allows a comprehensive evaluation of the educational processes, the interaction between students and teachers, and the effectiveness of study programs in the academic and professional training of students.

The work of Scott J. W. (2016) on "The Echo of Fantasy: History and the Construction of Identity" provides a relevant theoretical framework for understanding how educational experiences influence the construction of student identity. This study allows to deepen the understanding of how personal and collective narratives are formed and reformed within collaborative and dynamic educational environments, thus enriching the interpretation of the data collected in the proposed research. The application of these theoretical perspectives to the evaluation of collaborative and observational activities will allow a deeper understanding of the qualitative and quantitative impacts on the educational programs of Latin American Universities.

## **9 POPULATION AND SAMPLE**

The research worked with two audiences; the first corresponds to the faculty of the undergraduate and postgraduate courses offered by the Universities in Costa Rica and Latin America, and the second population to students who have participated in any of the educational offers of the university.

As for teachers, they are mainly experts in different areas of the different faculties of the Universities, each with extensive experience in face-to-face classes and most with little experience of virtualization. In addition, their scientific and research training is supported by



their educational level. As for their sociodemographic characteristics, these vary, as there are young teachers under 35 years of age. Shokoor (2022). As the student population varies in two groups, first by age and then by geographical origin. The ages would be grouped between undergraduate students, who are between the ages of 18 and 32, and those attending graduate courses, whose ages range from 30 years and older.

Another important point is the aspect of the courses offered by the American University, in the case of the General Methodology and Educational Activities that it provides to students:

- Each course has defined objectives and competencies to promote in the student body.
- Theoretical methodology – practice: a component part masterful (theoretical) and another component practical or fieldwork;
- A core aspect in the courses is fieldwork, where learning by inquiry is promoted that includes individual and collaborative work;
- In the master phase, activities such as: talks by specialists, teacher exhibitions and group and individual exhibitions of the students (research projects) are included;
- The educational activities of the courses demonstrate a constructivist approach that starts from the premise: “Learning by doing” in which they use strategies such as:
  1. Learning by inquiry;
  2. Project-based learning;
  3. Experiments, tests, among others. Hassija (2019)

## 9.1 POPULATION AND SAMPLE

Sousa (2022) defines population as the set of individuals or objects of interest or measures that are obtained from all individuals or objects of interest.

Population is taken into account in order to conjecture or say something about the population itself. Hiram (2022) indicates that it is the best conjecture that is possible to obtain from the value of a population based on information from a sample.

The research worked with two audiences; the first corresponds to the faculty of the undergraduate and graduate courses offered by the American University in Costa Rica, and the second population to students who have participated in any of the educational offers of the university.

As for teachers, they are mainly experts in different areas of the different faculties of the American University, each with extensive experience in face-to-face classes and most with



little experience of virtualization. In addition, their scientific and research training is supported by their educational level. As for their sociodemographic characteristics, these vary, as there are young teachers under 35 years Hirama (2022).

As the student population varies in two groups, first by age and then by geographical origin. The ages would be grouped between undergraduate students, who are between the ages of 18 and 32, and those attending graduate courses, whose ages range from 30 years and older.

The samples are taken due to logistical or economic difficulties to work with the total population. Being the total population 2500000 people, with a level of heterogeneity of 50%, we handle an error of 5% for a level of confidence of 95% giving the rigor and proper validity to a serious investigation. The following formula applies:

$$n = \frac{Z^2 N p q}{e^2 (N - 1) + Z^2 p q}$$

Where:

N: is the size of the population being considered. Z: is a constant that depends on the level of trust we assign. 95% (1.96). e: is the desired sample error, as a percent. For this case a 5%. p: probability of success. The value is usually assigned 50%. q: probability of failure. The value is usually assigned 50%. When solving the equation with the values that have been determined we find that the sample must be at least 385 people. For the study, 700 surveys were carried out in full compliance with the correct indexes to validate the study in its survey stage.

## 9.2 RELIABILITY AND VALIDITY

The reliability of a measuring instrument is estimated when it allows to determine that the same, measures what you want to measure, and applied several times, indicate the same result. Li and Jiunn Deng (2019) indicate that “the reliability of a measuring instrument refers to the degree to which its repeated application to the same subject or object yields equal results” (p. 243).

For the implementation of the methodological procedure, the pilot test already validated was applied to teachers who were not part of the sample, but who had the same characteristics of the sample subjects. To find the reliability coefficient, we proceeded as follows:

- a) Application of the test to a group of 700 subjects belonging to the study sample, with characteristics equivalent to it;
- (b) Coding of responses; transcription of responses into a double-entry tabulation matrix



supported by the Excel program;

c) Calculation of the Cronbach's Alpha Coefficient whose formula is:

$$\alpha = \left[ \frac{k}{k-1} \right] \left[ 1 - \frac{\sum_{i=1}^k S_i^2}{S_t^2} \right],$$

Where:

$S_i^2$  is the variance of item I,

$S_t^2$  is the variance of the total observed values

$k$  is the number of questions or items.

d) Interpretation of the values taking into account the scale suggested by Li and Jiunn Deng (2019):

**Figure 1**

*Validity of the investigation with its magnitude*

<b><u>RANGE</u></b>	<b><u>MAGNITUDE</u></b>
0.81 – 1.00	Very high
0.61 – 0.80	High
0.41 – 0.60	Moderate
0.21 – 0.40	Low
0.001 – 0.20	Very low

Table of Values of Cronbach's Alpha Coefficient Calculation

In the case of this study, when evaluating the surveys we found that the numerical values obtained.

### 9.3 VALIDITY PROCESSING

In order to analyze the surveys and validate their reliability they will be divided into two, in the first survey that we will call Survey it was taken to look like people who are karate practitioners, in the second survey people are interviewed about what have been implemented in the universities in the study, in this case we will call the instrument.



### 9.3.1 Survey Validity

In this survey 7 items are analyzed therefore  $k = 7$ .

When applying the formula we have to  $\alpha = \left[ \frac{k}{k-1} \right] \left[ 1 - \frac{\sum_{i=1}^k S_i^2}{S_t^2} \right]$ , separate the formula to process its results, Section1 corresponds to  $[k/(k-1)]$  and Section2 is  $[1 - ( \sum_{i=1}^k S_i^2 ) / S_t^2 ]$ , Since the formula is complex, we segment it considering  $( \sum_{i=1}^k S_i^2 )$  as the sum of Variances and  $S_t^2$  as the total of variances (VT in the tables).

The data from Survey A, then, are as follows:

**Figure 2**

*Table of validity of the investigation*

Variable	Magnitude
<b>k</b>	7
<b>Sum. Variances</b>	1.257126
<b>VT</b>	5.437261
<b>Section 1</b>	1.0625
<b>Section 2</b>	0.768794
<b>Cronbach's alpha</b>	0.816844

In the case of survey A, we have that the reliability level obtained is 0.816844, which was described as a very high magnitude on the Cronbach scale of analysis. It is then ruled that the designed instrument was valid and reliable to be applied to the study population.

## 10 ANALYSIS OF RESULTS

The main results of the two past surveys of students are presented below, organized in three sections (psychological aspects due to the pandemic to students and teachers, the adaptability part of the resources and the implementation of them). In the first, the general assessment of the students on the virtual class model is detailed; in the second, it is pointed out on the perception of the student's behavioral, affective and cognitive commitment to the virtual learning experience. Finally, in the last section, the suggestions and the positive and negative aspects exposed by the students in the open questions are shown.





## 10.1 PART ONE BASIC INFORMATION OF THE SURVEYS

This population does not present equipment problems, since almost 100% have a personal computer and a smart cell phone, this coincides with their frequency in Internet use. Equipment used for these classes are (cellular 7%, PC 23%, laptop 69% and tablet 1%).

## 10.2 VIRTUAL TOOLS USED BY TEACHERS IN THEIR PERSONAL LIVES

In general, these results show that the population knows and uses some of the virtual tools in their classes, this would increase the possibilities of application in other environments of their life, beyond everyday life. On the other hand, but related to this topic, it was consulted about its own perception regarding its technological fluidity, that is, its ease of use of different technologies. They are generally between an intermediate and advanced level with very similar percentages; only one person reported feeling at a basic level.

**Figure 3**

*Tools used by teachers in their virtual classes At UAM 27/03/2020*

Virtual Tool	Total number of students using it	%
UAM DIGITAL LIBRARY	25	3,57 %
EMAIL UAMCR.NET	44	6,28 %
GOOGLE DOCS	23	3,28 %
MOODLE (VIRTUAL CLASSROOM)	168	24 %
MS TEAMS	154	22 %
OFFICE 365	53	7,57 %
WHATSAPP	75	10,71 %
YOUTUBE	76	10,85 %
ZOOM	82	11,71 %
Grand total	700	

Source: Survey of <https://docs.google.com/> (700 students) / Note: For the construction of the research "The Internet community: a response in complex times"

**Figure 4***Level of satisfaction about the Virtual Classes implemented in the UAM 27/03/2020*

Experience with virtual distance classes	
COMPLETELY DISSATISFIED	91
DISSATISFIED	121
VERY SATISFIED	203
SATISFIED	282
(blank)	3
<b>TOTAL</b>	<b>700</b>

Source: Survey of <https://docs.google.com/> (700 students) / Note: For the construction of the research "The Internet community: a response in complex times"

## 11 CONCLUSIONS

The evolution towards "University 4.0" reflects a fundamental change in the educational landscape, emphasizing the integration of advanced methodologies and technologies to train professionals trained to face the challenges of the 21st century. This new paradigm promotes learning that is both dynamic and interdisciplinary, essential for thriving in the digital economy and knowledge society.

In this context, computer science and technological innovations have proven to be crucial tools, reforming higher education and providing learning environments that enhance skills vital to modern life and the work environment. The effective integration of ICT has become an imperative to ensure that all students have equitable access to educational resources, thus addressing the challenges of accessibility and equity.

The role of the teacher is evolving from being a mere transmitter of knowledge to becoming a facilitator of learning, a transformation that resonates with contemporary pedagogical theories and that underlines the importance of a student-centered educational approach. However, the transition to education 4.0 also involves overcoming the limitations of traditional teaching methods, which often focus more on memorization than on in-depth understanding and practical application of knowledge.

The integration of technological resources in teaching must go beyond their use as mere instruments to improve education; it is about using these technologies as tools to develop skills and competences essential for success in the personal, social and labor field. It is imperative that governments and educational institutions commit to creating the conditions for sustainable and equitable development that puts people at the center of the educational process.

In conclusion, the transition to more technologically integrated and learner-centered higher education is critical to preparing professionals of the future, ensuring that they are



equipped with the skills and knowledge needed to navigate and contribute to a globalized and technologically advanced world. This educational transformation, supported by research in diverse fields from engineering to public health, requires a holistic approach that addresses both technical competencies and cognitive and social skills, thus ensuring that higher education continues to be relevant and effective in the training of future leaders and professionals.

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