Universidad de Huelva

Departamento de Pedagogía

Modelo de transformación digital de universidades para avanzar en la era global

Memoria para optar al grado de doctora
presentada por:

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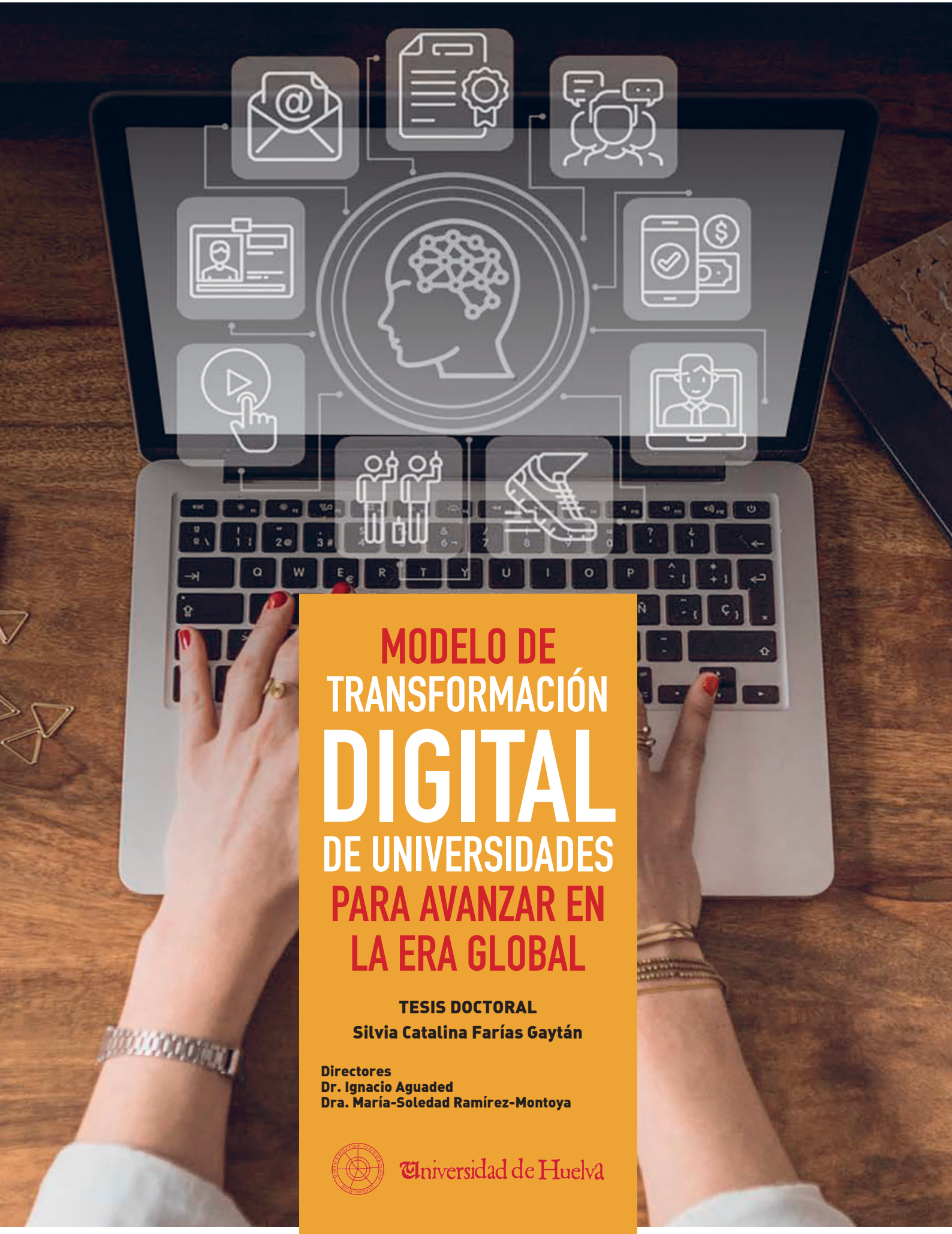

MODELO DE TRANSFORMACIÓN DIGITAL DE UNIVERSIDADES PARA AVANZAR EN LA ERA GLOBAL

TESIS DOCTORAL

Silvia Catalina Farías Gaytán

Directores
Dr. Ignacio Aguaded
Dra. María-Soledad Ramírez-Montoya

Universidad de Huelva

“La comunidad institucional debe caminar de la mano de la digitalización educativa para poder llegar a sus objetivos establecidos, tanto académicos como humanos, para así avanzar hacia un futuro sobresaliente en donde los egresados puedan distinguir la separación que existe entre sus habilidades y capacidades únicas y los beneficios y facilidades que otorga el uso de las nuevas tecnologías”

Observatorio.
Institute for the Future of Education.
2024

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Doctorado Interuniversitario en Comunicación

Huelva 2024

Universidad de Huelva · UNIVERSIDAD DE MÁLAGA · UCA Universidad de Cádiz · Universidad de Sevilla

Modelo de transformación digital de universidades para avanzar en la era global

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PRELIMINARES

RESUMEN – ABSTRACT

RESUMEN

El surgimiento del internet y la digitalización dieron lugar a la transformación digital de las organizaciones. Las instituciones de educación superior, en particular, deben estar atentas a los cambios del entorno y de la sociedad para asegurar que el estudiantado cuente con los conocimientos y habilidades demandadas. Este estudio se enfoca en el análisis de la transformación digital de las instituciones de educación superior con la finalidad de identificar los elementos que surgen en el entorno y los que las universidades están implementando. Lo anterior se realiza a través de 1) un análisis de las estrategias y tecnologías implementadas en educación superior utilizando revisión sistemática de literatura durante 2015-2022 en las bases de datos *Scopus* y *Web of Science* 2) el diseño de instrumentos para el análisis de las experiencias de dos universidades latinoamericanas, una en un caso de implementación de credenciales alternativas, y otra en la incorporación de educación digital; 3) la propuesta de DIG-HE modelo de transformación en la educación superior y su aplicación en la transferencia de una plataforma digital entre universidades como producto de la estancia de investigación en King's College London. Los hallazgos señalan que para que las instituciones de educación superior lleven a cabo la transformación digital de su organización deben definir una estrategia institucional, alinear sus procesos y habilitarlos con tecnología, así como asegurar que su gente, estudiantes, docentes y colaboradores, cuentes con las competencias digitales requeridas para su implementación.

Palabras clave
Transformación digital, alfabetización digital, educación superior, innovación educativa.

ABSTRACT

The emergence of the internet and digitalization gave rise to the digital transformation of organizations. Higher education institutions must be attentive to changes in the environment and society to ensure that students have the knowledge and skills in demand. This study focuses on the analysis of the digital transformation of higher education institutions with the purpose of identifying the elements that arise in the environment and those that universities are implementing. The above is done through 1) an analysis of the strategies and technologies implemented in higher education using a systematic literature review from 2015-2022 in the *Scopus* and *Web of Science* databases; 2) the design of instruments for analyzing the experiences of two Latin American universities, one a case study of alternative credentials implementation, and the other in the incorporation of digital education; 3) the proposal of the DIG-HE transformation model in higher education and its application in transferring a digital platform between universities as a result of a research stay at King's College London. The findings indicate that for higher education institutions to carry out the digital transformation of their organization, they must define an institutional strategy, align their processes, and enable them with technology, as well as ensure that their people, students, teachers, and collaborators, have the digital skills required for its implementation.

Keywords
Digital transformation, digital literacy, higher education, educational innovation.


Statistics
Receive
Send
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Market comparison
Shop A
Shop B
Total value
$35,903
Set credit limit
$1670
$0
$2000
25%
50%
18%
10%
Market popularity
Transaction history
Most recent
$130
Today
Receive
$240
Today
Send
$169
Today
150
130
100
12:30
Welcome

INTRODUCCIÓN

1. CONTEXTO Y RELEVANCIA DE LA INVESTIGACIÓN

La transformación digital ha impactado todos los ámbitos de la organización empujando la evolución de sus componentes tecnológicos, administrativos, así como a las personas que la integran. Esta transformación ha introducido nuevas tecnologías como redes sociales, *Big Data*, Internet de las cosas (IoT), entre otros, y prácticamente todas las industrias, de sistemas computacionales, de ingeniería, de negocios y de ciencias sociales las han incorporado (Pihir *et al.*, 2019). Las organizaciones han plasmado esta transformación en nuevos productos, procesos, canales de distribución y/o cadenas de suministro, incluso en el modelo de negocio (Hess *et al.*, 2016; Reis *et al.*, 2018). Un aspecto importante de la transformación digital es que requiere que la fuerza laboral cuente con las habilidades digitales necesarias para operar los cambios en procesos y operaciones de la organización (Verhoef *et al.*, 2019; Oberländer *et al.*, 2020). Las personas deben entrenarse en las habilidades digitales para ser capaces de desenvolverse en el nuevo mundo laboral.

Las nuevas habilidades digitales están íntimamente ligadas a las nuevas tecnologías e innovaciones digitales. Esto implica que no son estáticas; cambian rápidamente debido a los avances tecnológicos (Bokova & Galvin, 2017). Además, estos cambios demandan una continua actualización de la fuerza laboral para mantenerse vigente, ya que aquellos que no están alfabetizados digitalmente, o que tienen bajos niveles de alfabetización digital, serán menos propensos a tener la confianza, el conocimiento y la comprensión necesarios para participar de una manera segura e informada en un entorno digital (Pérez-Escoda *et al.*, 2016). Habilidades para codificar y decodificar mensajes audiovisuales se han convertido en un paso fundamental en términos de alfabetización, así como la alfabetización mediática y el uso de Internet (Aguaded, 2009; Aguaded-Gómez & Pérez-Rodríguez, 2012). Aspectos como ser capaces de manipular dispositivos y máquinas, así como el tipo de operaciones que realizan (Rampelt *et al.*, 2019), o poder operar tecnologías como internet de las cosas, robots, realidad aumentada o de inteligencia artificial, y dispositivos como tabletas y aplicaciones móviles (Sousa & Rocha, 2019). Ante este panorama, tanto la familia, como el gobierno, los medios de comunicación, así como la universidad deben participar y responder con programas de formación adecuados para el desarrollo de los estudiantes en las nuevas habilidades digitales (López & Aguaded, 2015). Habilidades que se consideraban tradicionalmente específicas de ciertos perfiles, ahora son básicas para la mayoría.

Los actuales estudiantes universitarios con acceso a los cambios tecnológicos los han ido adoptando e incorporando en todas sus actividades. Perciben a la tecnología como un eje de la sociedad de la información y un recurso inestimable para ofrecer oportunidades de desarrollo personal y profesional (Meneses *et al.*, 2020). La universidad además de preparar a los estudiantes frente al cambio también debe reconocer que es objeto del cambio digital, esto es, debe adaptarse para integrar en sus operaciones las nuevas tecnologías y tendencias digitales.

Por lo anterior, en las últimas décadas la universidad ha ido transformando la forma de impartir clases, así como actividades administrativas y de comunicación para mantenerse relevante para las nuevas generaciones. La transformación digital abarca mucho más que la simple implementación de nuevas tecnologías de información y comunicación (TIC). Si los colaboradores y/o usuarios no apoyan los enfoques sugeridos, las TIC recomendadas hacia el objetivo de la transformación digital podrían incluso ser contraproducentes (Petkovics, 2018). En consecuencia, la transformación digital de la universidad representa un proceso de cambio tecnológico y organizativo inducido por el desarrollo de las tecnologías digitales (Almaraz Menéndez *et al.*, 2016). La universidad debe identificar el estatus de transformación digital en el que se encuentra e identificar qué aspectos y tecnologías debe incorporar en sus procesos, además de determinar cómo es la mejor manera de realizarlo (Dolganova, 2020; Ibrahim & Ahmad Dahlan, 2016). Contar con un modelo de transformación digital que guíe a la universidad representa una oportunidad para asegurar que cubra todas las dimensiones de su cadena de valor.

La expectativa sobre la capacidad de la universidad para responder a los cambios externos se evidenció ante el reto de lograr la continuidad académica durante la contingencia sanitaria CoVid-19. La mayoría de los gobiernos alrededor del mundo se vieron obligados a cerrar temporalmente instituciones educativas de todos los niveles en un intento por contener la pandemia viéndose afectados 1,575,270,054 estudiantes, 91,3% del total de estudiantes matriculados (datos a abril 2020) (UNESCO, 2021). En México se vieron impactadas 6,404 instituciones de educación superior (IES), 4.7 millones de estudiantes y 429,495 docentes (Concheiro, 2020). Las instituciones tuvieron que replantear la manera de ofrecer sus programas académicos y sus procesos administrativos, así como capacitar a su planta docente para continuar operando.

Universidades con experiencia en educación a distancia pudieron responder más pronto, ya que contaban con infraestructura, tecnologías, así como expertos y programas de formación lo que les permitió implementar la modalidad a distancia en todos sus programas. Otras universidades con menos experiencia aprovecharon plataformas, cursos y recursos educativos abiertos para impartir clases de manera remota (DeVaney *et al.*, 2020). El reporte CHLOE 5 "The Pivot to Remote Teaching in Spring 2020 and Its Impact" (2020) publicado por *Quality Matters y Eduventures Research* (Garret *et al.*, 2020) encontró que el mayor reto que enfrentaron las instituciones fue la falta de preparación de la facultad y del estudiantado para el aprendizaje remoto dado que la tecnología se volvió el habilitador del aprendizaje, y fue necesario que tanto docentes como estudiantes desarrollaran nuevas habilidades en el corto plazo para continuar con el periodo escolar.

La revisión de la literatura reciente presenta pocos casos en los que la universidad haya adoptado un proceso sistemático y ordenado de transformación digital. Más aún, en México alrededor del 50% de 76 universidades declararon contar con menos de 100 cursos o recursos interactivos en formato digital para apoyo de clases presenciales o de oferta no presencial (ANUIES, 2020). El panorama se presenta retador, más es imperativo que las universidades inicien o continúen su transformación digital. Entendiéndose por transformación digital el "proceso que tiene como objetivo mejorar una entidad desencadenando cambios significativos en sus propiedades a través de combinaciones de tecnologías de información, computación, co-

municación y conectividad" (Vial, 2019, p. 118). En la transformación digital es necesario considerar que la organización puede ser la que introduce una nueva tecnología como innovación, sin embargo, también puede verse obligada a incorporarla porque sus usuarios, ya sean colaboradores o sus clientes, la utilizan. En el mundo digital la introducción de una nueva tecnología no siempre la realiza un experto o la alta administración, estos dejan de ser protagonistas (Majchrzak *et al.*, 2016). La transición de la organización hacia esta transformación se puede realizar en fases que van desde convertir la información análoga a digital ("digitazation"), y luego incorporar tecnologías digitales para modificar procesos a través de la digitalización ("digitalization"), y el cambio de mayor impacto se da en la transformación digital del modelo de negocio (Verhoef *et al.*, 2019). Ante esto la fuerza laboral se convierte en un elemento indispensable de la transformación digital. La organización requiere que las personas que la integran cuenten con las habilidades digitales necesarias para operar los cambios en procesos y operaciones (Verhoef *et al.*, 2019; Oberländer *et al.*, 2020). Asimismo, los responsables deben contar con experiencia en proyectos de transformación y alinear directamente sus incentivos con los objetivos y el progreso de la estrategia (Matt *et al.*, 2015). Este panorama es el que enfrenta la fuerza laboral actual, así como la que se encuentra en formación.

El avance de la universidad hacia la transformación digital puede variar entre sus diferentes unidades e incluso entre diferentes grupos (docentes, estudiantes, colaboradores). Algunas universidades han implementado cambios en la modernización de sus edificios y en la incorporación de innovación en su modelo educativo, sin embargo, en otros procesos como marketing y nuevas formas de atracción de estudiantes algunas han mostrado mesura en implementar cambios (Xiao, 2020). Asimismo, la estrategia que emplee la universidad hacia la transformación digital debe considerar temas de administración del cambio para integrar y sensibilizar a los involucrados. Por lo tanto, para lograr una implementación y despliegue orgánico es conveniente que la universidad cuente con una estrategia definida para lograr la transformación digital.

Si bien la transformación digital ya es un tema que está tomando relevancia entre las instituciones de educación superior, existe una oportunidad para apoyar la fundamentación de un modelo que sirva de referencia para las universidades hacia su transformación digital, lo cual implica explorar las tendencias y elementos que deben considerar, así como experiencias implementadas por universidades que sirvan como ejemplo guiar su camino.

INTRODUCCIÓN

ENFOQUE Y NATURALEZA DE LA TESIS POR COMPENDIO

La adopción de tecnologías por la sociedad abarca todos los aspectos de la vida del ser humano, y es así como las universidades deben estar atentas para incorporar los elementos de la tecnología que enriquezcan el aprendizaje y preparen al estudiantado para el mundo laboral. Este compendio de publicaciones aborda desde la línea de investigación de educomunicación las estrategias que las instituciones de educación superior utilizan al incorporar tecnología en el aprendizaje, así como en los procesos de operación y servicio que brindan, y en la formación de docentes y del estudiantado. Además, ofrece recomendaciones para incorporar innovaciones educativas.

El interés por esta temática ha sido alrededor del cual he desarrollado mi vida profesional desde hace veinte años en una institución de educación superior, la cual se ha destacado por enriquecer la experiencia de aprendizaje al incorporar y adaptar tecnologías que aporten valor a la educación, amplíen su alcance y estimulen la innovación educativa. En el año 2024 festeja 35 años de haber incursionado en la implementación de experiencias digitales y a distancia, en los cuales tuve la oportunidad de participar en diversos proyectos, así como ser estudiante y docente de educación en modalidad a distancia empleando diversas tecnologías, nuevas para su época. La primera experiencia que tuve con la tecnología en el aula fue en los años noventa con la impartición a través del uso del satélite, el cual me permitió, como estudiante, cursar una maestría y acceder a expertos de diferentes ciudades del país; asimismo, al trabajar como asistente académica en un curso impartido por satélite, aprendí las estrategias que se requieren para asegurar una experiencia educativa de calidad cuando el docente y los estudiantes se encuentran a la distancia.

Un segundo hito fue en la primera década del 2000 durante la adopción del Internet en la institución, lo cual detonó nuevos productos como cursos y programas en línea y se amplió el alcance a diferentes países y regiones del mundo; también trajo retos como diseñar soluciones educativas que fueran adecuadas considerando la diversidad de la infraestructura del estudiantado, su red y su equipo de cómputo personal, así como el uso de las primeras plataformas tecnológicas, redes sociales y el desarrollo de estrategias educativas adaptadas a la modalidad digital. Nunca hubo un momento aburrido, al contrario, se estimulaba la curiosidad e interés por buscar y probar recursos educativos digitales que contribuyeran al desarrollo del conocimiento y habilidades del estudiantado preparándolos para un mundo en constante cambio. También tuve la oportunidad de conocer la experiencia de aprendizaje como estudiante de una maestría en línea, lo cual puso de manifiesto la relevancia de aprender a utilizar nuevas herramientas TIC muy

útiles para el trabajo colaborativo a distancia, así como para mejorar la productividad de uno, además de entender lo importante que es conocer la situación del estudiante para el diseño e impartición de formación en modalidad digital, ya que los recursos e infraestructura varías entre regiones y países y esto puede afectar la experiencia del estudiantado.

La segunda década del 2000 introdujo otro hito en la educación con el surgimiento de los cursos masivos abiertos y en línea (MOOC por sus siglas en inglés), en el que también tuve oportunidad de participar liderando el proyecto en la institución. Esta innovación educativa generó espacios en los que universidades con interés en adoptar esta tendencia tenían la oportunidad de probar nuevos formatos, tecnologías, establecer alianzas y promover mejores prácticas con impacto internacional. Aun así, existía un escepticismo generalizado sobre la calidad de la modalidad digital por lo que su adopción se limitaba a las instituciones interesadas en buscar nuevas formas de enseñar y que contaban con recursos financieros para tener la infraestructura, humana y tecnológica, necesaria para el diseño e impartición de estos cursos.

Por último, a inicios de la tercera década del 2000 la contingencia sanitaria Covid-19 no dio opción, todos los niveles educativos a nivel mundial migramos a la educación remota durante dos años. Las universidades con experiencia en la modalidad digital pudieron adaptarse más rápidamente que otras sin experiencia. Fue una etapa muy demandante que puso de manifiesto el uso de la tecnología como un medio, una herramienta para facilitar el aprendizaje y la operación de las universidades, y que para lograrlo se requiere contar con estrategias educativas adecuadas, una facultad y estudiantado con las competencias digitales necesarias, así como una visión clara de la alta administración, y la infraestructura tecnológica y recursos financieros para su habilitación.

Para las instituciones de educación superior incorporar, adoptar y adaptar la tecnología en el aprendizaje deber ser parte de su estrategia y operación; el reto es asegurar que agregue valor, de manera que el aprendizaje sea siempre el fin y la tecnología el medio para enriquecerlo. Esto requiere más que solo buenas intenciones, requiere de las instituciones educativas estrategia, preparación, continuo interés por innovar, pero ¿qué consideraciones debe tener en cuenta? ¿quiénes deben participar? ¿qué procesos se deben llevar a cabo para seleccionar la tecnología más adecuada? ¿cómo incorporarla en el aprendizaje?

Como resultado de lo anterior nació mi inclinación por internarme más en el tema de la transformación digital de las instituciones de educación superior, y la opción de realizar una tesis por compendio supuso ir compartiendo con la comunidad científica los hallazgos durante el desarrollo de esta investigación. En este compendio se integran los resultados publicados en artículos de investigación, los cuales se interrelacionan para dar contexto y forma a este trabajo. El primer artículo «Transformación y alfabetización digital: mapeo sistemático de literatura» publicado en *Education and Information Technologies* (JCR-JIF Q1) (ver Anexo I) tuvo como objetivo analizar las publicaciones sobre transformación y alfabetización digital que impactan en la educación superior. Este estudio permitió recabar una perspectiva sobre los estudios de transformación digital en instituciones de educación superior y su enfoque de adopción.

El segundo artículo «Transformación digital y alfabetización digital en el contexto de la complejidad: Revisión Sistemática de Literatura» publicado en *Humanities and Social Sciences Communications* (JCR-JIF Q1) (ver Anexo II) se profundizó sobre las acciones que están tomando las universidades en la transformación digital del proceso de aprendizaje y los retos que enfrentan para el desarrollo de la alfabetización digital del estudiantado y de la facultad.

En el tercer artículo «Innovación educativa como un impulsor de la transformación digital de la universidad: Un caso de credenciales digitales en Latinoamérica» publicado en el *Journal of*

Interactive Media in Education (JCR-JIF Q1) (ver anexo III) se analizó un estudio de caso de una universidad mexicana, la cual implementó el uso credenciales alternativas en su oferta educativa, ya que éstas son un ejemplo de innovación educativa y se requiere de una serie de componentes para su despliegue como contar con una estrategia institucional, el diseño pedagógico de la oferta, la habilitación tecnológica, el proceso de evaluación y asignación, la acreditación y los procesos para su reconocimiento.

En el cuarto artículo «Transformación Digital en Educación Superior: Evaluación Cualitativa» publicado en *Frontiers in Education* (JCR-JIF Q2) (en revisión con la revista) se buscó busca identificar los elementos de la transformación digital de una universidad latinoamericana a través de su experiencia en la modalidad digital. La educación digital requiere el uso de tecnología para la entrega de la formación, lo cual implica que tanto docentes como estudiantes cuenten con las competencias digitales requeridas para que el uso de recursos educativos digitales no resulte en un impedimento para su aprendizaje. Asimismo, la universidad debe contar con la infraestructura adecuada para habilitar las experiencias de aprendizaje en tiempo y forma, y una estrategia clara de su implementación en la institución.

A continuación, presento la metodología llevada a cabo sobre la transformación digital de las instituciones de educación superior.

INTRODUCCIÓN

2. RESEARCH CONTEXT AND IMPLICATIONS

Digital transformation has impacted all areas of the organization, pushing the evolution of its technological and administrative components, as well as the people who make it up. This transformation has introduced new technologies such as social networks, Big Data, Internet of Things (IoT), among others, and virtually all industries, computer systems, engineering, business, and social sciences have incorporated them (Pihir *et al.*, 2019). Organizations have translated this transformation into new products, processes, distribution channels, and/or supply chains, including the business model (Hess *et al.*, 2016; Reis *et al.*, 2018). An important aspect of digital transformation is that it requires the workforce to have the digital skills necessary to operate changes in organizational processes and operations (Verhoef *et al.*, 2019; Oberländer *et al.*, 2020). People must train in digital skills to be able to function in the new world of work.

New digital skills are intimately linked to new technologies and digital innovations. This implies that they are not static; and change rapidly due to technological advances (Bokova & Galvin, 2017). In addition, these changes demand a continuous updating of the workforce to stay current, as those who are not digitally literate, or who have low levels of digital literacy, will be less likely to have the confidence, knowledge, and understanding necessary to participate in a safe and informed way in a digital environment (Pérez-Escoda *et al.*, 2016). Skills to encode and decode audiovisual messages have become a fundamental step in terms of literacy, as well as media literacy and the use of the Internet (Aguaded, 2009; Aguaded-Gómez & Pérez-Rodríguez, 2012). Aspects such as being able to manipulate devices and machines, as well as the type of operations they perform (Rampelt *et al.*, 2019), or being able to operate technologies such as the Internet of Things, robots, augmented reality, or artificial intelligence, and devices such as tablets and mobile applications (Sousa & Rocha, 2019). Faced with this panorama, the family, the government, the media, as well as the university must participate and respond with appropriate training programs for the development of students in the new digital skills (López & Aguaded, 2015). Skills that were traditionally considered specific to certain profiles are now basic for most.

Today's university students with access to technological changes have been adopting and incorporating them into all their activities. They perceive technology as an axis of the information society and an invaluable resource to offer opportunities for personal and professional development (Meneses *et al.*, 2020). In addition to preparing students for change, the university must also recognize that it is subject to digital change, that is, it must adapt to integrate new technologies and digital trends into its operations.

For this reason, in recent decades the university has been transforming the way classes are taught and administrative and communication activities to stay relevant for the new generations. Digital transformation encompasses much more than the simple implementation of new information and communication technologies (ICTs). If collaborators and/or users do not support the suggested approaches, the ICT recommended for the goal of digital transformation could even be counterproductive (Petkovics, 2018). Consequently, the digital transformation of the university represents a process of technological and organizational change induced by the development of digital technologies (Almaraz Menéndez- *et al.*, 2016). The university must identify the state of digital transformation in which it finds itself and identify what aspects and technologies it should incorporate into its processes, in addition to determining how best to carry it out (Dolganova, 2020; Ibrahim & Ahmad Dahlan, 2016). Having a digital transformation model that guides the university represents an opportunity to ensure that it covers all dimensions of its value chain.

The expectation about the university's ability to respond to external changes is evidenced by the challenge of achieving academic continuity during the COVID-19 health contingency. Most governments worldwide were forced to temporarily close educational institutions at all levels to contain the pandemic, affecting 1,575,270,054 students, 91.3% of the total number of students enrolled (data as of April 2020) (UNESCO, 2021). In Mexico, 6,404 higher education institutions (HEIs), 4.7 million students, and 429,495 teachers were impacted (Concheiro, 2020). Institutions had to rethink the way they offered their academic programs and administrative processes, as well as train their faculty to continue operating.

Universities with experience in distance education were able to respond sooner since they had infrastructure, technologies, as well as experts, and training programs, which allowed them to implement the distance modality in all their programs. Other less experienced universities leveraged open educational platforms, courses, and resources to teach remotely (DeVaney *et al.*, 2020). The CHLOE 5 report "The Pivot to Remote Teaching in Spring 2020 and Its Impact" (2020) published by *Quality Matters and Eduventures Research* (Garret *et al.*, 2020) found that the biggest challenge faced by institutions was the lack of preparation of faculty and students for remote learning as technology became the enabler of learning, and both teachers and students needed to develop new skills in the short term to continue with the school term.

The recent literature review presents a few cases in which the university has adopted a systematic and orderly process of digital transformation. Moreover, in Mexico, around 50% of 76 universities reported having fewer than 100 courses or interactive resources in digital format to support face-to-face classes or non-face-to-face classes (ANUIES, 2020). The outlook is challenging, but universities must start or continue their digital transformation. Digital transformation is understood as the "process that aims to improve an entity by triggering significant changes in its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019, p. 118). In digital transformation, it is necessary to consider that the organization may be the one that introduces a new technology as an innovation, however, it may also be forced to incorporate it because its users, whether they are collaborators or customers, use it. In the digital world, the introduction of new technology is not always carried out by an expert or senior management, they cease to be protagonists (Majchrzak *et al.*, 2016). The transition of the organization towards this transformation can be carried out in phases ranging from converting analog information to digital ("digitization"), and then incorporating digital technologies to modify processes through digitalization ("digitalization"), and the change with the greatest impact occurs in the digital transformation of the business model (Verhoef *et al.*, 2019). Given this, the workforce becomes an indispensable element of digital transformation. The or-

ganization requires that the people who make it up have the necessary digital skills to operate changes in processes and operations (Verhoef *et al.*, 2019; Oberländer *et al.*, 2020). In addition, managers must have experience in transformation projects and directly align their incentives with the objectives and progress of the strategy (Matt *et al.*, 2015). This is the scenario faced by today's workforce, as well as those in training.

The university's progress toward digital transformation can vary between its different units and even between different groups (teachers, students, collaborators). Some universities have implemented changes in the modernization of their buildings and in the incorporation of innovation in their educational model, however, in other processes such as marketing and new ways of attracting students, some have shown restraint in implementing changes (Xiao, 2020). Likewise, the strategy used by the university towards digital transformation must consider change management issues to integrate and raise awareness among those involved. Therefore, to achieve an organic implementation and deployment, it is convenient for the university to have a defined strategy to achieve digital transformation.

Although digital transformation is already a topic that is gaining relevance among higher education institutions, there is an opportunity to support the foundation of a model that serves as a reference for universities towards their digital transformation, which involves exploring the trends and elements that they should consider, as well as experiences implemented by universities that serve as an example to guide their path.

INTRODUCCIÓN

FOCUS AND NATURE OF THE THESIS BY COMPENDIUM

The adoption of technologies by society encompasses all aspects of human life, and this is how universities must be attentive to incorporating the elements of technology that enrich learning and prepare students for the world of work. This compendium of publications addresses from the Educommunication research line the strategies that higher education institutions use when incorporating technology in learning, as well as in the operation and service processes they provide, and in the training of teachers and students. In addition, it offers recommendations for incorporating educational innovations.

My interest in this topic has been around and I have developed my professional life for twenty years in a higher education institution, which has stood out for enriching the learning experience by incorporating and adapting technologies that add value to education, expand its scope, and stimulate educational innovation. The year 2024 celebrates 35 years of having ventured into the implementation of digital and distance experiences, in which I had the opportunity to participate in various projects and be a student and teacher of distance education using various technologies, new for its time. The first experience I had with technology in the classroom was in the nineties with teaching through the use of satellite, which allowed me, as a student, to pursue a master's degree and access experts from different cities in the country; Also, working as an academic assistant in a satellite-taught course, I learned the strategies required to ensure a quality educational experience when the teacher and students are at a distance.

A second milestone was in the first decade of the 2000s during the adoption of the Internet in the institution, which detonated new products such as online courses and programs and expanded the reach to different countries and regions of the world; It also brought challenges such as designing educational solutions that were adequate considering the diversity of the students' infrastructure, their network and their computer equipment, as well as the use of the first technological platforms, social networks and the development of educational strategies adapted to the digital modality. There was never a dull moment, on the contrary, curiosity and interest in searching for and testing digital educational resources that contributed to the development of students' knowledge and skills were stimulated, preparing them for an ever-changing world. I also had the opportunity to learn about the learning experience as a student of an online master's degree, which highlighted the relevance of learning to use new ICT tools that are very useful for collaborative work at a distance, as well as for improving one's productivity, in addition to understanding how important it is to know the student's situation for the design and delivery of training in digital mode, as resources and infrastructure vary between regions and countries and this can affect the student experience.

2.2 FOCUS AND NATURE OF THE THESIS BY COMPENDIUM

The second decade of the 2000s introduced another milestone in education with the emergence of massive open online courses (MOOCs), in which I also had the opportunity to participate in leading the project at the institution. This educational innovation created spaces where universities interested in adopting this trend had the opportunity to test new formats, and technologies, establish alliances, and promote best practices with international impact. Even so, there was widespread skepticism about the quality of the digital modality, so its adoption was limited to institutions interested in finding new ways of teaching and that had the financial resources to have the human and technological infrastructure necessary for the design and delivery of these courses.

Finally, at the beginning of the third decade of the 2000s, the Covid-19 health contingency did not give us an option, all educational levels worldwide migrated to remote education for two years. Universities with experience in the digital modality were able to adapt more quickly than those without experience. It was a very demanding stage that highlighted the use of technology as a means, a tool to facilitate the learning and operation of universities, and that to achieve this it is necessary to have adequate educational strategies, a faculty, and students with the essential digital skills, as well as a clear vision of senior management, and the technological infrastructure and financial resources for its enablement.

For higher education institutions, incorporating, adopting, and adapting technology in learning should be part of their strategy and operation; the challenge is to ensure that it adds value so that learning is always the end and technology is the means to enrich it. This requires more than just good intentions, it requires strategy, preparation and continuous interest in innovating from educational institutions, but what considerations should they consider? Who should participate? What processes should be carried out to select the most appropriate technology? How to incorporate it into learning?

As a result of the above, my inclination to delve more deeply into the topic of the digital transformation of higher education institutions was born, and the option of doing a thesis by compendium meant sharing the findings with the scientific community during the development of this research. This compendium integrates the results published in research articles, which are interrelated to give context and shape to this work. The first article "Digital Transformation and Literacy: Systematic Mapping of Literature" published in *Education and Information Technologies* (JCR-JIF Q1) (see Appendix I) aimed to analyze publications on digital transformation and literacy that impact higher education. This study provided a perspective on digital transformation studies in higher education institutions and their adoption approach.

The second article "Digital Transformation and Digital Literacy in the Context of Complexity: A Systematic Review of the Literature" published in *Humanities and Social Sciences Communications* (JCR-JIF Q1) (see Annex II) delved into the actions that universities are taking in the digital transformation of the learning process and the challenges they face for the development of digital literacy of the student body and the faculty.

In the third article "Educational Innovation as a Driver of the Digital Transformation of the University: A Case of Digital Credentials in Latin America" published in the *Journal of Interactive Media in Education* (JCR-JIF Q2) (see Appendix III) a case study of a Mexican university that implemented the use of alternative credentials in its educational offering, was analyzed. Since these are an example of educational innovation and a series of components are required for their deployment, such as having an institutional strategy, the pedagogical design of the offer, the technological qualification, the evaluation and assignment process, accreditation, and the processes for their recognition.

In the fourth article “Digital Transformation in Higher Education: Qualitative Evaluation” published in *Frontiers in Education* (JCR-JIF Q2) (under revision) we sought to identify the elements of the digital transformation of a Latin American university through its experience in the digital modality. Digital education requires the use of technology for the delivery of training, which implies that both teachers and students have the necessary digital skills so that the use of digital educational resources does not result in an impediment to their learning. Likewise, the university must have the appropriate infrastructure to enable learning experiences promptly, and a clear strategy for its implementation in the institution.

Below, I present the methodology carried out in the digital transformation of higher education institutions.

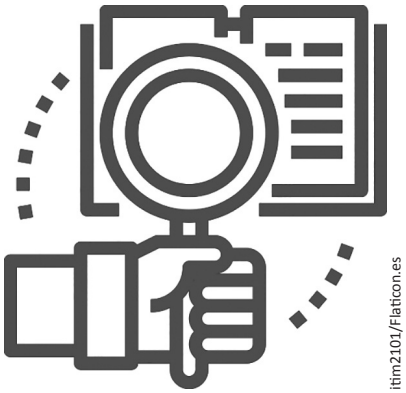
3. OBJETIVOS DE LA INVESTIGACIÓN

El objetivo general de esta investigación consiste en analizar el desarrollo de la alfabetización digital requerida por el medio laboral, a través de evaluar el impacto de la transformación digital en profesores y equipos de producción de cursos y recursos educativos digitales, con el fin de proponer un modelo de transformación digital para la universidad.

Pregunta de investigación: ¿Qué elementos deben considerar las instituciones de educación superior para llevar a cabo una transformación digital que aporte valor a su razón de ser y se mantenga relevante?

Los objetivos específicos de esta investigación son:

- Contrastar estrategias y tecnologías derivadas de la transformación digital con impacto en la educación y habilitar las principales funciones/áreas de la universidad.
- Analizar el impacto de la transformación digital en el desarrollo de la alfabetización digital en profesores y equipos de producción.
- Diseñar un modelo de transformación digital para la universidad que coadyuve al desarrollo de la alfabetización digital en la comunidad académica de universidades que aporte a la formación para la inserción en el mercado laboral de la era digital.



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Transformation and digital literacy: Systematic literature mapping

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Abstract
The advancements of technology have allowed digital transformation to reach all productive sectors, including the education sector and its members. This transformation is linked to emerging technologies, the digitalization of processes and resources, and the demand for users to upgrade to the latest technological updates. This research aims to analyze digital transformation and media literacy publications that impact higher education. Its purpose is to identify the types of research and topics they address and explore the scope of digital transformation in higher education institutions. The systematic mapping method was used to analyze 298 articles published in two databases, Scopus and Web of Science (WoS). Inclusion and exclusion criteria were applied to select the articles that could be included in this research. The results show that the largest proportion of articles were found in Scopus, and used both qualitative and quantitative empirical research methods, followed by theoretical-conceptual methods and, to a lesser extent, mixed methods. Likewise, the publications originated in five continents, and the *Journal of Adolescent and Adult Literacy* had the largest number of publications, with 14. Forty-two percent of the studies were classified in the strategy category, with the most mentioned topic being digital pedagogies. This research provides a perspective on digital transformation studies in higher education institutions and their internalization approaches. This research may be of value to trainers, students, decision-makers, and researchers interested in transformation, educommunication, and educational innovation.

Keywords Digital transformation · Media literacy · Higher education · Educational innovation · Systematic mapping · Educommunication

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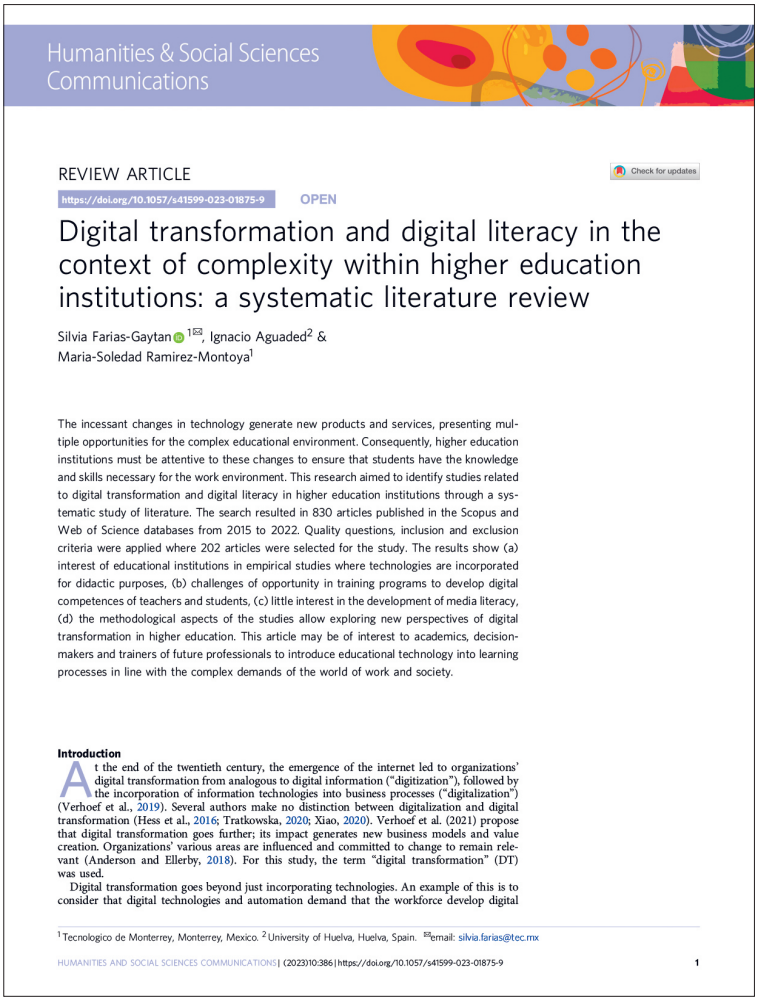
3.1 TRANSFORMACIÓN Y ALFABETIZACIÓN DIGITAL: MAPEO SISTEMÁTICO DE LITERATURA

El primer artículo responde al primer objetivo de la tesis para identificar las estrategias y tecnologías implementadas en instituciones de educación superior que incursionan en temas de transformación digital. Este análisis permitió identificar los países, métodos de investigación, categoría de transformación digital, así como distribución geográfica de los autores y revistas con mayor número de publicaciones en la temática.

En esta investigación se analizaron las publicaciones sobre transformación y alfabetización digital con impacto en la educación superior con el fin de identificar los tipos de investigación y temas que abordan y aportar datos para la educomunicación. Para llevar a cabo lo anterior, se realizó un mapeo sistemático de artículos publicados en el periodo 2015-2020 en las bases de datos de *Scopus* y *Web of Science*.



Humanities & Social Sciences Communications

REVIEW ARTICLE

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Digital transformation and digital literacy in the context of complexity within higher education institutions: a systematic literature review

Silvia Farias-Gaytan[1], Ignacio Aguaded[2] & Maria-Soledad Ramirez-Montoya[1]

The incessant changes in technology generate new products and services, presenting multiple opportunities for the complex educational environment. Consequently, higher education institutions must be attentive to these changes to ensure that students have the knowledge and skills necessary for the work environment. This research aimed to identify studies related to digital transformation and digital literacy in higher education institutions through a systematic study of literature. The search resulted in 830 articles published in the Scopus and Web of Science databases from 2015 to 2022. Quality questions, inclusion and exclusion criteria were applied where 202 articles were selected for the study. The results show (a) interest of educational institutions in empirical studies where technologies are incorporated for didactic purposes, (b) challenges of opportunity in training programs to develop digital competences of teachers and students, (c) little interest in the development of media literacy, (d) the methodological aspects of the studies allow exploring new perspectives of digital transformation in higher education. This article may be of interest to academics, decision-makers and trainers of future professionals to introduce educational technology into learning processes in line with the complex demands of the world of work and society.

Introduction

At the end of the twentieth century, the emergence of the internet led to organizations' digital transformation from analogous to digital information ("digitization"), followed by the incorporation of information technologies into business processes ("digitalization") (Verhoef et al., 2019). Several authors make no distinction between digitalization and digital transformation (Hess et al., 2016; Tratkowska, 2020; Xiao, 2020). Verhoef et al. (2021) propose that digital transformation goes further; its impact generates new business models and value creation. Organizations' various areas are influenced and committed to change to remain relevant (Anderson and Ellerby, 2018). For this study, the term "digital transformation" (DT) was used.

Digital transformation goes beyond just incorporating technologies. An example of this is to consider that digital technologies and automation demand that the workforce develop digital

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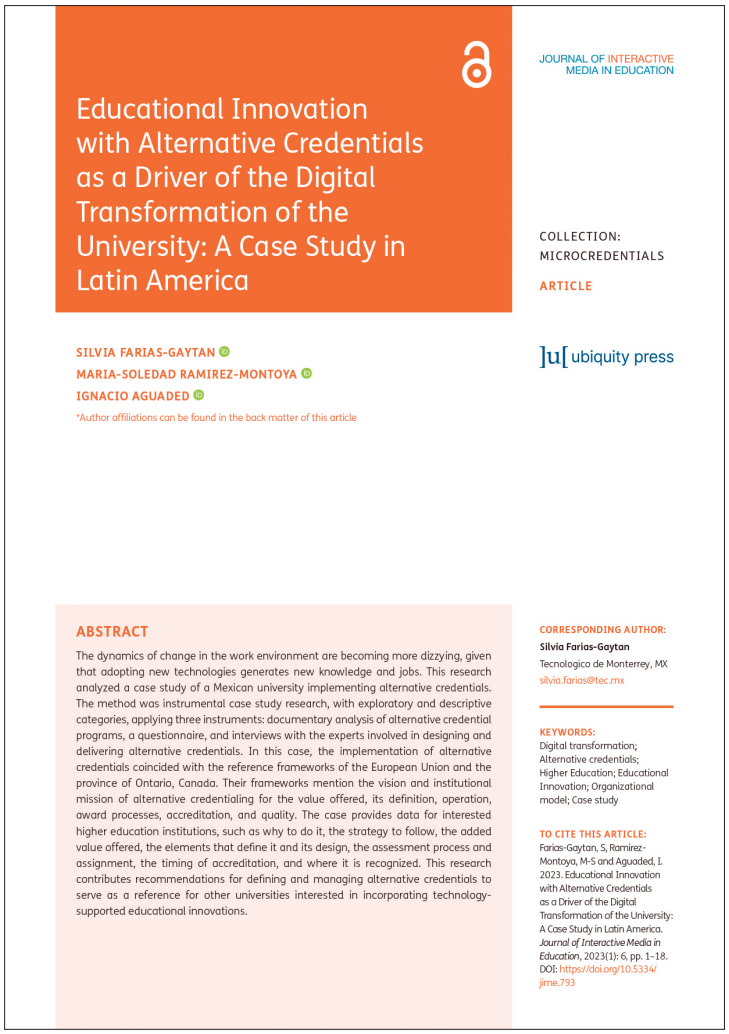
3.2 TRANSFORMACIÓN DIGITAL Y ALFABETIZACIÓN DIGITAL EN EL CONTEXTO DE LA COMPLEJIDAD: REVISIÓN SISTEMÁTICA DE LITERATURA

El segundo artículo contribuye también al primer objetivo, ya que se realizó una exploración más a detalle de estudios relacionados a los temas de transformación digital y alfabetización digital en instituciones de educación superior a través de un estudio sistemático de literatura ampliando el periodo de revisión al 2022.

El estudio busca responder qué tendencias educativas están utilizando las instituciones de educación superior, así como qué estudios han realizado al respecto, y las oportunidades que han identificado para avanzar en la transformación digital y la alfabetización digital de docentes y estudiantes.



Educational Innovation with Alternative Credentials as a Driver of the Digital Transformation of the University: A Case Study in Latin America

JOURNAL OF INTERACTIVE MEDIA IN EDUCATION

COLLECTION: MICROCREDENTIALS

ARTICLE

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ABSTRACT

The dynamics of change in the work environment are becoming more dizzying, given that adopting new technologies generates new knowledge and jobs. This research analyzed a case study of a Mexican university implementing alternative credentials. The method was instrumental case study research, with exploratory and descriptive categories, applying three instruments: documentary analysis of alternative credential programs, a questionnaire, and interviews with the experts involved in designing and delivering alternative credentials. In this case, the implementation of alternative credentials coincided with the reference frameworks of the European Union and the province of Ontario, Canada. Their frameworks mention the vision and institutional mission of alternative credentialing for the value offered, its definition, operation, award processes, accreditation, and quality. The case provides data for interested higher education institutions, such as why to do it, the strategy to follow, the added value offered, the elements that define it and its design, the assessment process and assignment, the timing of accreditation, and where it is recognized. This research contributes recommendations for defining and managing alternative credentials to serve as a reference for other universities interested in incorporating technology-supported educational innovations.

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KEYWORDS:
Digital transformation; Alternative credentials; Higher Education; Educational Innovation; Organizational model; Case study

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3.3 INNOVACIÓN EDUCATIVA CON CREDENCIALES ALTERNATIVAS COMO UN IMPULSOR DE LA TRANSFORMACIÓN DIGITAL DE LA UNIVERSIDAD: ESTUDIO DE CASO EN LATINOAMÉRICA

Este artículo contribuye al segundo objetivo cuyo fin es presentar la experiencia de una institución de educación superior mexicana en la implementación de credenciales alternativas, para identificar mejores prácticas que sirvan de referencia en esta tendencia.

La implementación de credenciales alternativas en una organización significa la consideración de diversos componentes de la dinámica de una institución de educación superior para que la definición, diseño, despliegue y comunicación de las credenciales alternativas sea una experiencia comprensible y brinde valor al estudiante.

3.4 EVALUATION OF THE DIGITAL TRANSFORMATION OF A LATIN AMERICAN HIGHER EDUCATION INSTITUTION BY INCORPORATING DIGITAL EDUCATION

Este artículo contribuye al segundo objetivo, ya que se identificar los elementos de la transformación digital de una universidad latinoamericana a través de su experiencia en la incursión en la educación digital.

A través del análisis de esta experiencia se identifican las acciones deseables a llevar a cabo para implementar programas de educación digital, así como las competencias que deben dominar los involucrados para el diseño de cursos de educación digital.

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4. METODOLOGÍA

La selección del enfoque de investigación tiene en cuenta las preguntas de investigación, los destinatarios del estudio, así como el método de investigación para la recopilación, análisis e interpretación de datos (Creswell, 2014). Los métodos de investigación de esta tesis por compendio fueron seleccionados para cubrir los objetivos planteados en cada artículo (Tabla 1).

Tabla 1. *Metodología implementada en los artículos de investigación*

Trabajo	Metodología / Técnicas	Objetivo	Alcance
Transformación y alfabetización digital: Mapeo sistemático de literatura	Revisión sistemática	Analizar el estado del arte de la transformación digital y alfabetización mediática en la educación superior.	Publicaciones científicas en el periodo 2015-2020.
Transformación digital y alfabetización digital en el contexto de la complejidad: Revisión sistemática de literatura	Revisión sistemática	Identificar estudios recientes relacionados a los temas de transformación digital y alfabetización digital en instituciones de educación superior.	Publicaciones científicas en el periodo 2015-2022.
Innovación educativa con credenciales alternativas como un impulsor de la transformación digital de la universidad: Estudio de caso en Latinoamérica	Estudio de caso/ Entrevistas Cuestionarios Análisis documental	Presentar la experiencia de una institución de educación superior mexicana en la implementación de credenciales alternativa.	Una institución de educación superior latinoamericana.
Transformación digital en educación superior: Evaluación cualitativa (en evaluación con la editorial)	Método cualitativo / Entrevistas	Identificar los elementos de la transformación digital de una universidad latinoamericana a través de su experiencia en la incursión en la educación digital.	Un equipo multidisciplinario encargado del diseño de cursos de educación digital de una universidad latinoamericana.
DIG-HE Modelo de transformación digital en la educación superior: Un modelo de implementación- (artículo complementario en evaluación con la editorial)	Diseño basado en investigación	Definir son los componentes de un modelo de transformación digital que guíe la toma de decisiones en la Educación Superior para seleccionar el mejor camino y seguir siendo relevante para las necesidades de la sociedad	
Descifrando el enigma de una transferencia de plataforma digital: diseño basado en la investigación y pensamiento complejo (artículo complementario en evaluación con la editorial)	Diseño basado en investigación	Presentar el proceso de transferencia de una plataforma digital entre universidades para educación digital	Una institución de educación superior

4.1 REVISIÓN SISTEMÁTICA DE LITERATURA

En los primeros dos artículos se aplicó la metodología de revisión de literatura para determinar el estado del arte de los constructos de la investigación, la transformación digital y la alfabetización digital. Esta técnica proporciona los medios para identificar, evaluar e interpretar la literatura publicada disponible sobre un tema de estudio (García-Peñalvo, 2017; Kitchenham and Charters, 2007), y es necesario establecer un protocolo para el análisis de los estudios (Ramírez-Montoya and Lugo-Ocando, 2020).

En el artículo «Transformación y alfabetización digital: Mapeo sistemático de literatura» (Farias-Gaytan *et al*., 2021) se definieron seis preguntas de investigación para determinar el estado del arte sobre transformación digital y alfabetización digital en instituciones de educación superior; estas preguntas ayudaron a ubicar cuántos y dónde se están llevando a cabo estas experiencias, las publicaciones, así como las tendencias y temas abordados; además, se utilizó el Modelo de Madurez Digital (Anderson & Ellerby, 2018) para identificar el enfoque de las experiencias de las IES. Se revisó la información del resumen, las palabras clave y el título del artículo para categorizar cada artículo. El resultado de la búsqueda en las bases de datos *Scopus* y *Web of Science* arrojó 374 artículos, se eliminaron duplicados, se aplicaron criterios de inclusión y exclusión y se consideró el rango de 2015 a 2020 quedando 274 artículos para dar respuesta a las preguntas de investigación.

En el segundo artículo «Transformación digital y alfabetización digital en el contexto de la complejidad: Revisión sistemática de literatura» (Farias-Gaytan *et al.*, 2023a) se amplió la búsqueda de estudios incluyendo a los publicados en 2022. Se aplicó igualmente un protocolo para la búsqueda, selección y análisis de los artículos resultantes (Kitchenham *et al.*, 2010). Se definieron seis preguntas de investigación para identificar las tendencias y tópicos abordados teniendo como referencia las cuestiones emergentes en el uso de la tecnología educativa planteadas por González-Pérez *et al* (2019) y que se refieren a pedagogías digitales, modelos tecnológicos, tecnologías adaptativas, tecnologías abiertas, tecnologías inteligentes y tecnologías disruptivas. El número de artículos encontrados en *Scopus* y *Web of Science* publicados entre 2015 y 2022 fue de 830, y siguiendo los criterios de inclusión y exclusión resultaron en 202 artículos con los cuales se realizó el análisis.

4.2 ESTUDIO DE CASO

Los hallazgos de la a revisión sistemática de literatura permitieron identificar las tendencias y tópicos de la transformación digital, así como las categorías de aplicación en las IES, por consiguiente, se procedió a analizar un estudio de caso en el artículo «Innovación educativa con credenciales alternativas como un impulsor de la transformación digital de la universidad: Estudio de caso en Latinoamérica» (Farias-Gaytan *et al.*, 2023b) de una tendencia que impulsa y requiere que la organización aborde la transformación digital de procesos, habilitadores, visión y gente. Al centrar el enfoque en un grupo particular se puede obtener un análisis detallado de la experiencia de estudio (Merriam, 2002; Yin, 2009). Se aplicaron tres instrumentos: entrevistas, cuestionarios y análisis de documentos (Creswell, 2014; Merriam, 2002). La muestra del estudio estuvo integrada por tres expertos, dos docentes diseñadores de los cursos y el líder del equipo de diseño de los cursos de credenciales alternativas. Para el análisis de los datos se categorizaron las respuestas del cuestionario y las entrevistas con base en los modelos de Pichette *et al.* (2021) y Hudak y Camilleri (2018) (Tabla 2) dado que estos marcos de referencia correspondían a casos de instituciones de educación superior, y la intención era relacionar el caso de estudio con las experiencias de otras universidades.

Tabla 2. Categorías de análisis de información

Micro-credentials Quality Markers for Postsecondary Institutions (Pichette *et al.*, 2021)	The Micro-Credential (MCs) Users' Guide (Hudak and Camilleri, 2018)
Definición	Definición y Clasificación.
Relevante: Consultado o involucrado en la industria/comunidad.	Visión, Misión y Estrategia para las credenciales alternativas a nivel institucional.
Flexible: El ritmo y/o la estructura del aprendizaje se pueden personalizar.	
Acreditado: Reconocido o emitido por un organismo de acreditación profesional.	Acreditación y aseguramiento de calidad.
Estandarizado: cumple con un estándar de calidad establecido por el gobierno.	Otorgamiento de credenciales alternativas.
Evaluado: El alumno debe demostrar habilidades / conocimientos para obtener la credencial.	
Apilable: Puede ser "apilado" o combinado hacia una credencial superior, por ejemplo, un diploma o título.	Reconocimiento académico y portabilidad de credenciales alternativas.

Las características de análisis de los marcos de referencia se relacionaron con los reactivos del instrumento (Farías-Gaytan *et al.*, 2023c) para encontrar relaciones entre ellos, y se encontraron similitudes en la mayoría de ellos lo que denota los intereses y preocupaciones comunes entre las instituciones de educación superior con respecto a la implementación de credenciales alternativas. El análisis de los resultados permitió generar una propuesta para la gestión de credenciales alternativas.

4.3 MÉTODO CUALITATIVO

En el cuarto manuscrito «Transformación digital en educación superior: Evaluación cualitativa» (Farias-Gaytan *et al.*, under evaluation a) se investigó sobre otra tendencia educativa, la educación digital, y cómo se implementa en la educación superior. Se utilizó el método cualitativo para registrar la experiencia de una universidad latinoamericana, ya que con este método el investigador se hace cercano e interactúa con los participantes y para esto se utilizaron entrevistas para recolectar la información (Creswell, 2014). Para realizar las entrevistas se diseñó un instrumento con 51 preguntas abiertas (Farías et al, under evaluation b), las cuales se organizaron en secciones cuatro secciones: a) estrategia (lineamientos institucionales que aplican a la organización), b) procesos (operaciones que habilitan los servicios de valor), c) tecnología (infraestructura que habilita la educación digital), y d) gente (involucrados y requerimientos para llevar a cabo la edu-

cación digital). Estas categorías se desprendieron del framework para eLearning en instituciones de educación superior de García-Peñalvo (2021) y la guía de implementación integral de educación digital en universidades del Tecnológico de Monterrey (Observatorio IFE, 2024) (Tabla 3).

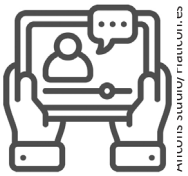
Tabla 3. Categorías de análisis

An institutional reference framework for eLearning in higher education **(García-Peñalvo, 2021)**	**Educación digital en las Universidades: una guía de implementación integral** **(Observatorio IFE, 2024)**
• Policy and strategy • Identity and communication • Ethics, privacy and security issues • Adaptation of the academic services • Educational model • Contents • Infrastructure	1. Por qué o para qué 2. Procesos para definir la oferta digital 3. Incorporación del aprendizaje digital en el modelo educativo de la universidad 4. Seguimiento a la implementación y aseguramiento de la calidad 5. Normatividad y acreditaciones externas 6. Infraestructura tecnológica y de servicios 7. Financiamiento 8. Tecnologías educativas 9. Cultura organizacional

4.4 DISEÑO BASADO EN INVESTIGACIÓN

En dos artículos complementarios se utilizó la metodología de diseño basado en investigación para diseñar el modelo DIG-HE de transformación digital en la educación superior y su validación en un estudio realizado durante la estancia de investigación en King's College London. La razón de utilizar esta metodología es que está orientada a mejorar las prácticas educativas a través de una revisión sistemática, flexible e iterativa, análisis, diseño, desarrollo e implementación, basados en la colaboración entre investigadores y profesionales en entornos del mundo real, y que conduzcan a principios o teorías de diseño (Wang and Hannafin, 2005). Con base en las características de esta metodología en el artículo «DIG-HE Modelo de transformación digital en la Educación Superior: modelo de implementación» (Farias-Gaytan *et al.*, under evaluation c) se presenta cómo se conjuntaron los hallazgos de los estudios previos para el desarrollo del modelo DIG-HE, esto es, las revisiones sistemáticas, el diseño de instrumentos y el análisis de experiencias de transformación digital de credenciales alternativas y de educación digital en IES.

Asimismo, para el segundo estudio complementario «Descifrando el enigma de una transferencia de plataforma digital: diseño basado en la investigación y pensamiento complejo» (Farias-Gaytan *et al.*, under evaluation d) se utilizaron como referencia los hallazgos sobre transformación digital en IES de las revisiones sistemáticas (Farias-Gaytan *et al.*, 2021; Farias-Gaytan *et al.*, 2023a) se diseñó la estrategia para la transferencia de la tecnología y se



validaron los componentes operativos del modelo DIG-HE considerando los casos de las dos universidades participantes.

4.5 CONSIDERACIONES ÉTICAS

En cada una de las investigaciones se consideraron las cuestiones éticas pertinentes. Los procesos éticos en los estudios abordan varios dilemas éticos (Creswell 2007; Lincoln & Guba 1985), como los participantes, la gestión de datos y la difusión de los datos generados. Antes de iniciar el trabajo de campo en las investigaciones donde se contó con participantes y expertos, se les presentó información extensa y detallada sobre el propósito académico de la investigación, así como del alcance de su participación. El manejo de los datos se realizó de manera objetiva para garantizar la confidencialidad y el anonimato de las opiniones de los participantes (Traxler, 2012). Los datos fueron analizados y resguardados, y la difusión de estos se realizó a través de artículos publicados con fines académicos y de investigación.

En la primera y segunda investigación, en las cuales se realizaron revisiones de literatura, se incluyó la referencia a las bases de datos analizadas como evidencia del trabajo realizado y que sirva de punto de partido para otras investigaciones. En la tercera investigación, estudio de caso, se anonimizaron las respuestas de los participantes para garantizar la confidencialidad de las opiniones utilizando los datos obtenidos únicamente con fines académicos y de investigación. Asimismo, en el cuarto estudio, en el cual se utilizaron entrevistas para recabar la información, y dado que el método cualitativo permite un acercamiento entre el investigador y el entrevistado para recopilar sus experiencias (Creswell *et al.*, 2004; Merriam, 2002), se aseguró el resguardo de la información proporcionada en carpetas con acceso limitado, y se anonimizaron las respuestas para garantizar la confidencialidad de los participantes.

ARTÍCULOS TEMÁTICOS DE LA TESIS POR COMPENDIO

TRANSFORMATION AND DIGITAL LITERACY: SYSTEMATIC LITERATURE MAPPING

Farias-Gaytan, S., Aguaded, I. & Ramirez-Montoya, MS.

Transformation and digital literacy: Systematic literature mapping.

Educ Inf Technol (2021). https://doi.org/10.1007/s10639-021-10624-x
JCR-JIF Q1

The advancements of technology have allowed digital transformation to reach all productive sectors, including the education sector and its members. This transformation is linked to emerging technologies, the digitalization of processes and resources, and the demand for users to upgrade to the latest technological updates. This research aims to analyze digital transformation and media literacy publications that impact higher education. Its purpose is to identify the types of research and topics they address and explore the scope of digital transformation in higher education institutions. The systematic mapping method was used to analyze 298 articles published in two databases, *Scopus* and *Web of Science* (WoS). Inclusion and exclusion criteria were applied to select the articles that could be included in this research. The results show that the largest proportion of articles were found in *Scopus*, and used both qualitative and quantitative empirical research methods, followed by theoretical-conceptual methods and, to a lesser extent, mixed methods. Likewise, the publications originated in five continents, and the *Journal of Adolescent and Adult Literacy* had the largest number of publications, with 14. Forty-two percent of the studies were classified in the strategy category, with the most mentioned topic being digital pedagogies. This research provides a perspective on digital transformation studies in higher education institutions and their internalization approaches. This research may be of value to trainers, students, decision-makers, and researchers interested in transformation, educommunication, and educational innovation.

Artículo completo en Anexo I

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DIGITAL TRANSFORMATION AND DIGITAL LITERACY IN THE CONTEXT OF COMPLEXITY: SYSTEMATIC LITERATURE REVIEW

Farias-Gaytan, S., Aguaded, I. & Ramirez-Montoya, MS.

Digital transformation and digital literacy in the context of complexity within higher education institutions: a systematic literature review.

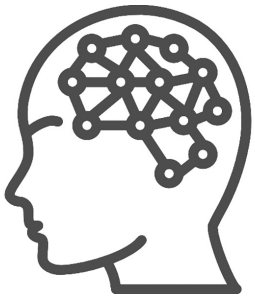
Humanit Soc Sci Commun 10, 386 (2023).

https://doi.org/10.1057/s41599-023-01875-9

JCR-JIF Q1

The incessant change of technology generates new products and services, presenting multiple opportunities for the complex educational environment. Consequently, higher education institutions must be attentive to these changes to ensure that students have the knowledge and skills necessary for the work environment. This research aimed to identify studies related to digital transformation and digital literacy in higher education institutions through a systematic study of literature. The search resulted in 830 articles published in the *Scopus* and *Web of Science* databases from 2015 to 2022. Quality questions, inclusion and exclusion criteria were applied where 202 articles were selected for the study. The results show (a) interest of educational institutions in empirical studies where technologies are incorporated for didactic purposes, (b) challenges of opportunity in training programmes to develop digital competences of teachers and students, (c) little interest in the development of media literacy, (d) the methodological aspects of the studies allow exploring new perspectives of digital transformation in higher education. This article may be of interest to academics, decision-makers, and trainers of future professionals to introduce educational technology into learning processes in line with the complex demands of the world of work and society.

Artículo completo en Anexo II



EDUCATIONAL INNOVATION WITH ALTERNATIVE CREDENTIALS AS A DRIVER OF THE DIGITAL TRANSFORMATION OF THE UNIVERSITY: A CASE STUDY IN LATIN AMERICA

Farias-Gaytan, S, Ramirez-Montoya, M-S and Aguaded, I. 2023.

Educational Innovation with Alternative Credentials as a Driver of the Digital Transformation of the University: A Case Study in Latin America.

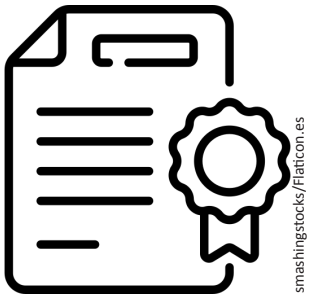
Journal of Interactive Media in Education, 2023(1): 6, pp. 1–18.

DOI: https://doi.org/10.5334/jime.793

JCR-JIF Q1

The dynamics of change in the work environment are becoming more dizzying, given that adopting new technologies generates new knowledge and jobs. This research analyzed a case study of a Mexican university implementing alternative credentials. The method was instrumental case study research, with exploratory and descriptive categories, applying three instruments: documentary analysis of alternative credential programs, a questionnaire, and interviews with the experts involved in designing and delivering alternative credentials. In this case, the implementation of alternative credentials coincided with the reference frameworks of the European Union and the province of Ontario, Canada. Their frameworks mention the vision and institutional mission of alternative credentialing for the value offered, its definition, operation, award processes, accreditation, and quality. The case provides data for interested higher education institutions, such as why to do it, the strategy to follow, the added value offered, the elements that define it and its design, the assessment process and assignment, the timing of accreditation, and where it is recognized. This research contributes recommendations for defining and managing alternative credentials to serve as a reference for other universities interested in incorporating technology-supported educational innovations.

Artículo completo en Anexo III



DIGITAL TRANSFORMATION IN HIGHER EDUCATION: QUALITATIVE EVALUATION

Farias-Gaytan, S., Aguaded, I., & Ramírez-Montoya, M. S. (under evaluation).

Evaluation of the digital transformation of a Latin American higher education institution by incorporating digital education.

Frontiers in Education.

JCR-JIF Q2

Digital transformation goes beyond the implementation of technology in institutions; its adoption impacts their strategy and organization, processes, products and services and, as a consequence, they require talent to meet the new demands of the work environment. The aim of this research was to analyze the elements of digital transformation in higher education through an experience in digital education. The research was carried out with the qualitative evaluative method, applying interviews to multidisciplinary staff of a Latin American university, with four categories of analysis: strategy, people, technology, and processes. The results showed that (a) it is important to have an institutional strategy that guides and enables the implementation of digital education in the university to promote its adoption; (b) the updating and retraining of talent is essential to carry out the digital transformation in the organization; (c) the digital transformation of roles, products, and services requires continuous investment in technology infrastructure, and (d) requires a rethinking of processes to take advantage of and scale new technologies. This study may be of value to administrators, teachers, and decision-makers interested in carrying out digital transformation actions in educational institutions.

Artículo en evaluación con la revista

benzoix/Freepick

ARTÍCULOS COMPLEMENTARIOS

Las indagaciones y aprendizajes de esta investigación permitieron llevar a la práctica la aplicación del conocimiento en situaciones del entorno real. Asimismo, derivado de los hallazgos prácticos y de los sustentos teóricos encontrados en el análisis de la producción científica del momento, se pudo concretar la propuesta de un modelo de transformación digital en la educación superior. En esta sección se presentan dos publicaciones en evaluación sobre la transformación digital en educación superior de un proyecto realizado durante la estancia de investigación en King's College London, Reino Unido y la propuesta del modelo DIG-HE, objetivo de esta tesis doctoral. Estas dos publicaciones están planeadas para presentarse en conferencias internacionales.

DIG-HE Digital Transformation Model in Higher Education: An Implementation Model

JCR-JIF SCOPUS | Farías-Gaytán, S., Aguaded, I., Wilberforce, T., & Ramírez-Montoya, M.S. (under evaluation). Proceedings of the 12th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM2024). University of Alicante. Spain.

Digital transformation has become a constant state for organisations, including higher education institutions. This research aims to answer the question: What are the components of a digital transformation model that guides decision-making in Higher Education to select the best path to remain relevant to society's needs? The method for defining the model was research-based design with three phases: 1) context analysis (SLR and mapping), 2) analysis of digital transformation experiences in higher education, and 3) a proposal of a digital transformation model for higher education. The findings are: (a) a philosophical component which are quality, equitable, and solidarity-based education, inclusive digital worldview, culture of innovation and continuous improvement, and collective construction of digital knowledge; (b) a theoretical component supported by the theories of complexity, management of educational change, educational innovation, and experiential learning; (c) a policy component that refers to digital participatory governance, digital ethics and privacy, open access and equity policies, and cooperation and strategic alliances to guide the processes in the educational context, and (d) an operational component that interrelates strategy, process, technology, people, implementation, and evaluation with its inputs and outputs. The DIG-HE model is intended to be of value to academic communities and management interested in digital transformation initiatives.

Proceedings en Anexo V

Decoding the Enigma of a Digital Platform Transfer: Research-Based Design and Complex Thinking.

JCR-JIF Q2 | Ramírez-Montoya, M.S., Aguaded, I., Tariq, R., Wilberforce, T., Martínez-Reyes, M., & Farías-Gaytán, S. (under evaluation). Proceedings of the 12th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM2024). University of Alicante. Spain.

Cracking the code of digital learning environment transfer involves unraveling the complexities of migrating educational content and practices across diverse digital ecosystems, paving the way for a future where learning is seamless, adaptive, and universally accessible What are the key enigmatic pieces that need to be considered in the transfer of digital platforms? The research-based design method was applied, through the transfer of a digital platform developed in a research project in Mexico to a platform for a research project in England, with didactic components based on a model of complex thinking, computational thinking, digital transformation model for higher education institutions, and technological components with open resources. The data locates the key pieces of: (a) Educational internationalization, (b) Cultural localization, (c) Technological interoperability, (d) Learning analytics, (e) Pedagogical innovation, (f) Financial and operational sustainability. This study enriches the decision-making process by fostering the exchange and transfer of knowledge between institutions. It is intended to be of value to academic and research communities and developers interested in educational innovation processes.

Proceedings en Anexo VI

CONCLUSIONES

La aspiración de realizar esta tesis por compendio de investigaciones fue contribuir al conocimiento en aras de poner a disposición los hallazgos obtenidos a través de los diferentes estudios e intercambios con participantes de las investigaciones y con otros colegas investigadores para que sirva a otros como punto de partida en sus iniciativas de transformación digital. La emoción e incertidumbre que genera el recién advenimiento de la inteligencia artificial generativa nos debe hacer conscientes de que se necesitan tomar decisiones informadas que, a la vez que abren las puertas a innovaciones y nuevas ideas para probar y explorar, también deben ser cautelosas para atender los riesgos que se perciben a primera vista, y a aquellos que surgirán de pronto.

Considero que la transformación digital en el sector educativo amplía las posibilidades para abrir el acceso a la educación a comunidades excluidas, flexibilizar la experiencia de aprendizaje en tiempo y lugar, y brindar nuevos productos educativos como credenciales alternativas para seguir aprendiendo a lo largo de la vida. No obstante, existen riesgos inherentes como la concentración de la tecnología en [pocos] grandes consorcios, el costo educativo que el siglo pasado consistía principalmente en material impreso, ahora se agrega el costo de material digital como licencias de software y recursos educativos digitales, de dispositivos móviles y equipo de cómputo; además hay que considerar cuestiones de seguridad y privacidad de datos que entre más sofisticada la tecnología también incrementa su vulnerabilidad.

A continuación, se presentan las principales conclusiones con base en los objetivos planteados en esta investigación.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Objetivo 1. Contrastar estrategias y tecnologías derivadas de la transformación digital con impacto en la educación y habilitar las principales funciones/áreas de la universidad.

El análisis del contexto debe realizarse para poder ubicar al sujeto de la investigación considerando elementos que ayuden a identificar las características deseadas. En este caso los análisis sistemáticos de literatura me permitieron identificar estrategias y uso de tecnologías en la educación superior en un periodo de siete años. Asimismo, fue de interés para esta investigación los retos y limitaciones que reportaron estos estudios para poder delinear el camino que han emprendido las IES en la transformación digital.

Los hallazgos destacan que la implementación de estrategias y tecnologías derivadas de la transformación digital se encuentran presentes en los cinco continentes y muestran un crecimiento constante en las últimas dos décadas; asimismo su uso es diverso, ya sea para enriquecer el proceso de enseñanza-aprendizaje, mejorar procesos operativos y la estrategia de la organización, así como el desarrollo de competencias de estudiantes y docentes. En este respecto el desarrollo de competencias digitales de los docentes requiere hacer el uso pedagógico adecuado para lograr los objetivos de aprendizaje más allá de la incorporación de tendencias o nuevos artefactos, así como la evaluación del desempeño para guiar la estrategia de implementación.

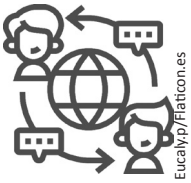
Cabe destacar que un aspecto de interés para las IES es el impacto del uso de las tecnologías en el desempeño del estudiante y del docente, y brindar capacitación fue uno de los aspectos con mayor mención entre los estudios. Esto detona que las IES cuenten con los procesos e infraestructura, tecnologías adecuadas para que la facultad y el estudiantado estén preparados para el ambiente laboral. Asimismo, demanda que las IES tengan claridad en qué y cómo llevarán a cabo esta transformación digital para cubrir las necesidades de sus públicos.

Objetivo 2. Analizar el impacto de la transformación digital en el desarrollo de la alfabetización digital en profesores y equipos de producción.

Para llevar a cabo el análisis del impacto de la transformación digital en las IES se desarrollaron dos instrumentos para registrar la experiencia de dos universidades latinoamericanas en la implementación de innovaciones educativas como son las credenciales alternativas y la educación digital. Ambos estudios fueron cualitativos y se tuvo acercamiento con los responsables de la implementación a través de entrevistas y aplicación de cuestionarios. Los hallazgos de las revisiones de literatura sirvieron de base para guiar la estructura de los instrumentos como es la estrategia que normó la implementación de las innovaciones en cada institución, los procesos y la tecnología que habilitan la implementación y despliegue con la facultad y el estudiantado, así como las iniciativas que emplean para asegurar que los usuarios tengan las competencias necesarias para su utilización.

En el caso del estudio de credenciales alternativas, la institución de educación superior interesada en probar esta tendencia estableció los medios y grupos de trabajo para implementarla, lo cual implicó la adaptación de procesos y la adopción de tecnologías, alianzas con proveedores de plataformas tecnológicas, así como la capacitación de los roles involucrados en el diseño de los cursos, además de generar un proceso de educomunicación para informar al estudiantado de su uso y cómo se realiza su reconocimiento, todo esto regido por lineamientos institucionales que aseguraran la calidad académica.

De igual forma, se realizó otro estudio sobre la implementación de cursos de educación digital en una institución superior latinoamericana teniendo acceso a un grupo de especialistas encargados de su implementación. La estrategia de educación digital estaba normada en la institución, por lo que contaba con una oferta y estructura definida para su despliegue. El grupo res-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ponsable de la educación digital contaba con procesos y tecnologías para llevar a cabo los cursos de educación digital, sin embargo los nuevos desarrollos generados por la transformación digital dan la sensación de que uno nunca está completamente preparado, ya que siempre surge algo nuevo que probar y evaluar y esto demanda que los roles especialistas lleven una capacitación continua en el uso de nuevas herramientas y estrategias didácticas, así como para implementar procesos de evaluación para la mejora continua.

Objetivo 3. Diseñar un modelo de transformación digital para la universidad que coadyuve al desarrollo de la alfabetización digital en la comunidad académica de universidades que aporte a la formación para la inserción en el mercado laboral de la era digital.

Como resultado de los hallazgos y aprendizajes de los estudios realizados se integró el modelo DIG-HE de transformación digital en la educación superior para concretar este objetivo. En la conceptualización del modelo DIG-HE se tuvo en cuenta la continua evolución de la tecnología y de la innovación educativa por lo que se propone un enfoque iterativo para la toma de decisiones de manera que se realice una reflexión continua sobre las iniciativas que se introduce en la ruta de transformación digital para validar su pertinencia y aporte de valor a los productos y servicios de las IES. Este modelo se sustenta en cuatro componentes que fungen como pilares de éste: (a) un componente filosófico con cuatro constructos: la educación de calidad, equitativa y solidaria, la cosmovisión digital inclusiva, la cultura de innovación y mejora continua, y la construcción colectiva del conocimiento digital; b) un componente teórico sustentado en las teorías de la complejidad, la gestión del cambio educativo, la innovación educativa y el aprendizaje experiencial; (c) un componente de política que se refiere a la gobernanza participativa digital, la ética digital y la privacidad, el acceso abierto y las políticas de equidad, y la cooperación y las alianzas estratégicas para guiar los procesos en el contexto educativo, y (d) un componente operativo que interrelaciona la estrategia, el proceso, la tecnología, las personas, la implementación y la evaluación con sus insumos y productos.

Además, como resultado de la estancia de investigación en King's College London se probó el modelo DIG-HE en un proyecto de transferencia de una plataforma digital entre IES para solventar las necesidades de educación digital y llevar formación a estudiantes en diversos países. En este estudio se identificaron los componentes del modelo DIG-HE brindando asesoría sobre elementos de la estrategia que debe considerar la IES adoptadora, el proceso de transferencia que se siguió, la adaptación de la plataforma tecnológica a las necesidades del nuevo usuario, así como capacitación a los expertos en contenido y usuarios de la plataforma.

En resumen, la preparación de las IES para abordar y llevar a cabo la transformación digital de sus instituciones puede resultar abrumadora debido al surgimiento cada vez más frecuente de tendencias que parecen prometedoras para atender necesidades y aspiraciones de mejora continua e innovación, por lo que es importante contar con una dirección que marque el rumbo a los involucrados en la toma de decisiones y en su educomunicación oportuna a la comunidad educativa.


mute
video settings
screen share
participants
chat
record
hang up

LIMITACIONES Y FUTURAS LÍNEAS DE INVESTIGACIÓN

Los hallazgos de esta investigación se recopilaron a través de estudios realizados en un periodo de tiempo determinado y con grupos de participantes acotados a los temas planteados utilizando procesos metodológicos cualitativos como el análisis de entrevistas y cuestionarios, así como el análisis documental. Estos estudios muestran el estado del arte en una fracción del tiempo, como una instantánea, así como las experiencias de una muestra de la población en su contexto inmediato en torno a la transformación digital en instituciones de educación superior, en consecuencia, se tornan en limitantes dado que la evolución de la tecnología y su aplicación en la educación deriva en nuevas oportunidades y estrategias para el proceso de enseñanza-aprendizaje y que instituciones de educación superior continúan explorando e implementando en las aulas.

Aunque en la revisión de la literatura se buscó identificar el estado del arte de las tendencias e innovaciones asociadas a diversas tecnologías en el ámbito educativo, se estableció un periodo que abarcó del 2015 al 2022. Asimismo, dado que el enfoque de la investigación es sobre las instituciones de educación superior, la búsqueda se circunscribió a este nivel educativo y las experiencias que han implementado en el proceso de enseñanza-aprendizaje. Por último, se definieron dos bases de datos a consultar con el fin de asegurar el uso de artículos publicados en revistas indexadas, las cuales cuentan con lineamientos y criterios para asegurar la calidad de las publicaciones. Lo criterios anteriores, periodo de tiempo, nivel educativo y bases de datos, aunque de utilidad para el enfoque de la investigación, fungen como limitantes en cuanto a que representan una vista localizada de la transformación digital del ámbito educativo.

En cuanto a la transformación digital, ésta va más allá de incorporar tecnología en los procesos de las instituciones de educación superior; esta transformación debe estar regida por una estrategia institucional y dentro de un marco que dirija su implementación. En este estudio se analizaron las experiencias de dos universidades en Latinoamérica y participaron los grupos que llevaron a cabo la experiencia en cada institución. La intervención a través de entrevistas y cuestionarios con los participantes proporcionó su perspectiva y experiencia directa en el desarrollo y la implementación, si bien no se incluyeron a otras áreas involucradas que participan habilitando para que grupos especializados lleven a cabo estas experiencias.

En cuanto a una futura línea de investigación sobre la transformación digital de las instituciones de educación superior, más allá de las diversas tendencias que surgen a la par que evoluciona la tecnología, se desprenden dos aspectos importantes a considerar en el ámbito educativo como la forma en que las instituciones deben organizarse para responder ágilmente al analizar y adoptar los cambios de la transformación digital que enriquezcan sus procesos de valor; nuevas funciones, estructuras y/o reconversión de las existentes que entiendan las tendencias, puedan valorarlas más allá del "ruido publicitario" e intereses económicos de las empresas patrocinadoras, y resulten en mejoras de la experiencia educativa. Asimismo, el monitoreo de las competencias digitales, y nuevas competencias que surjan por la transformación digital, que docentes y estudiantes deben desarrollar para prepararse al cambiante entorno laboral, incluyendo aspectos éticos y de seguridad, los cuales pueden representar riesgos, ya que el impacto potencial de las tecnologías se va manifestando durante su implementación. Así se presenta la educación mediada por tecnología, ¡siempre hay algo nuevo que aprender y explorar!

CONCLUSIONS

The aspiration of carrying out this thesis as a research compendium was to contribute to knowledge in order to make available the findings obtained through the different studies and exchanges with research participants and with other research colleagues so that it serves others as a starting point in their digital transformation initiatives. The excitement and uncertainty generated by the recent advent of generative artificial intelligence should make us aware that informed decisions need to be made that, while opening the doors to innovations and new ideas to test and explore, must also be cautious to address the risks that are perceived at first glance. and those that will suddenly arise.

I believe that digital transformation in the education sector expands the possibilities to open access to education to excluded communities, make learning experience more flexible in time and place, and provide new educational products as alternative credentials to continue learning throughout life. However, there are inherent risks such as the concentration of technology in [few] large consortia, the educational cost that in the last century consisted mainly of printed material, now the cost of digital material such as software licenses and digital educational resources, mobile devices and computer equipment is added; in addition, data security and privacy issues must be considered that, the more sophisticated, the more the technology also increases its vulnerability.

The main conclusions based on the objectives set out in this research are presented below.

Objective 1. Distinguish strategies and technologies derived from digital transformation with an impact on education and enable the main functions/areas of the university.

The analysis of the context must be carried out in order to locate the subject of study, considering elements that help to identify the desired characteristics. In this case, systematic literature reviews allowed me to identify strategies and use of technologies in Higher Education over a seven-year period. Likewise, the challenges and limitations reported by these studies were of interest for this research in order to outline the path that HEI have undertaken in digital transformation.

The findings highlight that the implementation of strategies and technologies derived from digital transformation are present in the five continents and showed constant growth in the last two decades; likewise, its use is diverse, either to enrich the teaching-learning process, improve operational processes and the organization's strategy, as well as the development of student and teacher competencies. In this regard, the development of teachers' digital competencies requires making the appropriate pedagogical use to achieve learning objectives beyond the incorporation of trends or new artifacts, as well as performance evaluation to guide the implementation strategy.

It should be noted that an aspect of interest for HEI is the impact of the use of technologies on student and teacher performance, and providing training was one of the aspects with the most mention among the studies. This triggers HEI to have the appropriate processes and infrastructure, technologies so that faculty and students are prepared for the work environment. It also demands that HEI be clear about what and how they will carry out this digital transformation to meet the needs of their audiences.

Objective 2. To analyze the impact of digital transformation on the development of digital literacy in teachers and production teams.

To carry out the analysis of the impact of digital transformation on HEI, two instruments were developed to record the experience of two Latin American universities in the implementation of educational innovations such as alternative credentials and digital education. Both studies were qualitative and those responsible for the implementation were approached through interviews and the application of questionnaires. The findings of the literature reviews served as a basis to guide the structure of the instruments, such as the strategy that regulated the implementation of innovations in each institution, the processes and technology that enable the implementation and deployment with faculty and students, as well as the initiatives they employ to ensure that users have the necessary competencies to use them.

In the case study of alternative credentials, the HEI interested in testing this trend established the means and working groups to implement it, which implied the adaptation of processes and the adoption of technologies, alliances with providers of technological platforms, as well as the training of the roles involved in the design of the courses. In addition to generating an educommunication process to inform students of its use and how its recognition is carried out, all this governed by institutional guidelines that ensure academic quality.

Similarly, another study was carried out on the implementation of digital education courses in a Latin American HEI, having access to a group of specialists in charge of their implementation. The digital education strategy was regulated in the institution, so it had a defined offer and structure for its deployment. The group responsible for digital education had processes and technologies to carry out digital education courses, however the new developments generated by digital transformation give the feeling that one is never fully prepared, since something new always arises, and this demands that specialist roles have continuous training in the use of new tools and didactic strategies, and evaluation processes for continuous improvement.

Objective 3. To design a digital transformation model for the university that contributes to the development of digital literacy in the academic community of universities that contributes to training for insertion in the labor market of the digital era.

As a result of the findings and learnings from the studies carried out, the DIG-HE model of digital transformation in Higher Education was integrated to achieve this objective. The conceptualization of the DIG-HE model took into account the continuous evolution of technology and educational innovation, so an iterative approach to decision-making is proposed so that continuous reflection is carried out on the initiatives that are introduced in the digital transformation route to validate their relevance and value contribution to the products and services of HEI. This model is based on four components that serve as its pillars: (a) a philosophical component with four constructs: quality, equitable and supportive education, an inclusive digital worldview, a culture of innovation and continuous improvement, and the collective construction of digital knowledge; (b) a theoretical component based on theories of complexity, educational change management, educational innovation and experiential learning; (c) a policy component that refers to digital participatory governance, digital ethics and privacy, open access and equity policies, and cooperation and strategic alliances to guide processes in the educational context, and (d) an operational component that interrelates strategy, process, technology, people, implementation and evaluation with their inputs and outputs.

In addition, as a result of the research stay at King's College London, the DIG-HE model was tested in a project to transfer a digital platform between HEI to solve the needs of digital education and bring training to students in various countries. In this study, the components of the DIG-HE

model were identified, providing advice on elements of the strategy that the adopting HEI should consider, the transfer process that was followed, the adaptation of the technological platform to the needs of the new user, as well as training for content experts and users of the platform.

In summary, the preparation of HEI to address and carry out the digital transformation of their institutions can be overwhelming due to the increasingly frequent emergence of trends that seem promising to meet needs and aspirations for continuous improvement and innovation, so it is important to have a direction that sets the course for those involved in decision-making and in their timely educommunication to the educational community.

LIMITATIONS AND FUTURE RESEARCH INTERESTS

The findings of this research were collected through studies carried out in a given period and with groups of participants limited to the topics raised using qualitative methodological processes such as the analysis of interviews and questionnaires, and documentary analysis. These studies show the state of the art in a fraction of the time, as a snapshot, as well as the experiences of a sample of the population in its immediate context around the digital transformation in HEI, consequently, they become limiting given that the evolution of technology and its application in education derives in new opportunities and strategies for the teaching-learning process and that education institutions continue to explore and implement in the classrooms.

Although the literature review sought to identify the state of the art of trends and innovations associated with various technologies in the educational field, a period was established that covered from 2015 to 2022. Likewise, given that the focus of the research is on HEI, the search was limited to this educational level and the experiences they have implemented in the teaching-learning process. Finally, two databases were defined to be consulted in order to ensure the use of articles published in indexed journals, which have guidelines and criteria to ensure the quality of the publications. The above criteria, period of time, educational level and databases, although useful for the research approach, serve as limitations in that they represent a localized view of the digital transformation of the education sector.

As for digital transformation, it goes beyond incorporating technology into the processes of HEI; this transformation must be governed by an institutional strategy and within a framework that directs its implementation. In this study, the experiences of two universities in Latin America were analyzed and the groups that carried out the experience in each institution participated. The intervention through interviews and questionnaires with the participants provided their perspective and direct experience in the development and implementation, although other areas involved that participated were not included, enabling specialized groups to carry out these experiences.

Regarding a future line of research on the digital transformation of HEI, beyond the various trends that arise as technology evolves, two important aspects to consider in the educational field emerge, such as the way in which institutions must organize themselves to respond quickly when analyzing and adopting the changes of digital transformation that enrich their value processes; new functions, structures and/or reconversion of existing ones that understand the trends, can value them beyond the “advertising noise” and economic interests of the sponsoring companies, and result in improvements in the educational experience. Likewise, the monitoring of digital competencies, and new competencies that arise from the digital transformation, that teachers and students must develop to prepare for the changing work environment, including ethical and security aspects, which can represent risks, since the potential impact of technologies is manifested during their implementation. This is how technology-mediated education is presented, there is always something new to learn and explore!

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PHP
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HTML
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ANEXO I

Education and Information Technologies
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Artículo. Transformation and digital literacy: Systematic literature mapping

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Abstract
The advancements of technology have allowed digital transformation to reach all productive sectors, including the education sector and its members. This transformation is linked to emerging technologies, the digitalization of processes and resources, and the demand for users to upgrade to the latest technological updates. This research aims to analyze digital transformation and media literacy publications that impact higher education. Its purpose is to identify the types of research and topics they address and explore the scope of digital transformation in higher education institutions. The systematic mapping method was used to analyze 298 articles published in two databases, *Scopus* and *Web of Science* (WoS). Inclusion and exclusion criteria were applied to select the articles that could be included in this research. The results show that the largest proportion of articles were found in *Scopus*, and used both qualitative and quantitative empirical research methods, followed by theoretical-conceptual methods and, to a lesser extent, mixed methods. Likewise, the publications originated in five continents, and the *Journal of Adolescent and Adult Literacy* had the largest number of publications, with 14. Forty-two percent of the studies were classified in the strategy category, with the most mentioned topic being digital pedagogies. This research provides a perspective on digital transformation studies in higher education institutions and their internalization approaches. This research may be of value to trainers, students, decision-makers, and researchers interested in transformation, educommunication, and educational innovation.

Keywords
Digital transformation, Media literacy, Higher Education, Educational Innovation, Systematic mapping, Educommunication

Introduction
The development of technologies accelerated with the introduction and growth of the internet during the last century. During the last decade of the 20th century, the internet facilitated companies to reach more users within and beyond their territories. Since the beginning of the 21st century, social networks and mobile devices have changed how we communicate with each other (Schallmo *et al.*, 2017). Companies committed to developing their information systems and digitalizing their processes have produced the current digital transformation (Osmundsen, 2020; Vial, 2019). This digital transformation is understood as the formation of networks of actors, such as companies and customers, in all value chain segments and the application of new technologies (Schallmo *et al.*, 2017). However, digital transformation goes beyond just the use of technology; it must consider changes in talent, culture, and organizational structure. (Kane *et al.*, 2017) (see Table 1). Both the public and private sectors have adopted technological advances,

although not all have done so in the same way. Nevertheless, this has boosted their development (Jackson, 2019; Pihir *et al.*, 2019). Even the education sector has not been left out of this transformation.

Table 1. *Digital Transformation Categories* (Anderson & Ellerby, 2018)

Category	Description
Customer	Providing an experience where customers view the organization as their digital partner using their preferred channels of interaction to control their connected future on and offline.
Strategy	Focuses on how the business transforms or operates to increase its competitive advantage through digital initiatives; it is embedded within the overall business strategy.
Technology	Underpins digital strategy's success by creating, processing, storing, securing, and exchanging data to meet the customers' needs at low cost and low overheads.
Operations	Executing and evolving processes and tasks by utilizing digital technologies to drive strategic management and enhance business efficiency and effectiveness.
Organization & Culture	Defining and developing an organizational culture with governance and talent processes to support progress along the digital maturity curve and flexibly achieve growth and innovation objectives.

Universities have embarked on the road to digital transformation and have incorporated technologies in their educational, administrative, and communication processes. Advances such as educational technology platforms and electronic communications such as email and social media messaging (Sjöberg & Lilja, 2019) are used regularly in the university. Both teachers and students have access to these technologies and digital resources, which has been a catalyst for universities to reassess their traditional education models. (Bond *et al.*, 2018; Jackson, 2019). Moreover, to drive and ensure the university's digital transformation, it is necessary to develop both the teachers' and students' skills (Bond *et al.*, 2018; Khitskov *et al.*, 2017) to adapt and use advanced technology. Technological changes have caused users to learn and unlearn, develop new competencies, be spectators, and even contribute content.

Users of technology must acquire the knowledge and skills to use it effectively for their learning. One of the challenges is that users must dedicate time to develop new skills to operate and apply the technology (Fucili *et al.*, 2020; Mendieta Baltodano, 2016; Salmieri, 2019). The classroom's digital transformation goes beyond the use of tools and software; it impacts the knowledge and skills of its users, teachers, and students, and the didactics and processes of educational institutions (Fucili *et al.*, 2020; Mendieta Baltodano, 2016; Salmieri, 2019). Examples of using educational technology can be found in digital pedagogies, technology models, and adaptive, open, smart, and disruptive technologies (González-Pérez *et al.*, 2019). Members of educational institutions must be attentive and prepared to keep abreast of the changes brought about by digital transformation.

The skills required for education and work have been subject to change along with technologies. Digital literacy emerged concurrently with the internet's evolution and required knowing how to access, search, and critically analyze information (Liu *et al.*, 2020). With the advent of social networks such as YouTube and Pinterest and access to mobile devices, users have developed new skills to generate digital resources, characterizing media literacy (Koc & Barut, 2016; Liu *et al.*, 2020). As technology continually evolves, the new skills will not remain static but will continuously change (UNESCO, 2017) (see Table 2). The challenge remains for institutions and individuals to identify, adapt, and adopt the advances to their contextual needs.

Other studies related to digital literacy have provided considerations for mappings. Among the studies is Juergens (2020), highlighting when geospatial data literacy is essential to judge spatial data reliability, contributing to ingenious and reliable thematic maps. Likewise, Da Silva & Cardoso (2020) focused their study on Librarianship and

Table 2. *Specific emerging issues in the use of educational technology* (González-Pérez *et al.*, 2019)

Categories
• Digital pedagogies: adapting pedagogical and technological resources to each area of knowledge. An example is b-learning, an environment with multimedia technologies. • Technology models: integrating innovation models with technology, such as smart innovation systems, research-based design. • Adaptive technologies: introduce new e-learning systems that adapt to the new needs of society; foster adaptive learning and educational systems (e.g., e-portfolios and Web 2.0). • Open technologies: enable open access for the dissemination of open knowledge, including open platforms, repositories, open resources, MOOCs, and open science. • Smart technologies: use smart tools and devices, such as *Big Data*, data mining, data analytics, cloud technologies, cloud computing in educational contexts, m-learning. • Disruptive technologies: involve new processes and services with leapfrog technologies, such as augmented reality, sensory stimulation, abstract imagery, virtual and remote laboratories.

Education, where they highlighted the current social demand for this sector to support lifelong learning in the context of accelerating technological progress. While this research considered the previous contributions, it also sought to analyze publications on digital transformation and media literacy that impacted higher education in 2015-2020 to identify the types of research and topics they addressed and provide data for educommunication. A systematic mapping of articles published in 2015-2020 was performed to carry out the above. This document presents the methodology, results, discussion, and limitations of the research, and it closes with a discussion of digital literacy trends to contribute to educommunication.

Research questions

This study investigated the types of research published on the topic of digital transformation and media literacy. The following research questions were defined to obtain timely information on the topic:

- RQ1: How many studies are in the Scopus and WoS databases between 2015 and 2020, and what is their design?
- RQ2: What are the most cited articles?
- RQ3: What is the geographical distribution of the authors?
- RQ4: Which are the journals with the largest publications on this topic?
- RQ5: How are digital transformation studies classified?
- RQ6: What are the trends and topics addressed by the articles?

Method

The method applied in this research was systematic literature mapping, which provides the means to identify, evaluate, and interpret the published literature available on a study topic. (García-Peñalvo, 2017; Kitchenham & Charters, 2007). The protocol applied to analyze the articles, as shown in Figure 1, consisted of five phases (Ramírez-Montoya & Lugo-Ocando, 2020).

Figure 1. Protocol for the analysis of methodological mapping

1.Definition of research questions

During phase 1, six questions were established to analyze the research published over five years (2015-2020). The questions were designed to cover the research's objective and identify relevant and specific characteristics that could answer the questions shown in Table 3 (García-Peñalvo, 2017; Kitchenham & Charters, 2007). In particular, the questions emanated from the interest in integrating the subject in aspects of education, innovation, and educommunication to provide data that can be of value for training and research processes. Table 3 lists the research questions, and the type of answer sought.

Table 3. *Research questions* (self-elaborated)

Research Question	Type of Answer sought
RQ1: How many studies are in the Scopus and Web of Science databases between 2015 and 2020, and what is their design?	No. of articles in Scopus No. of articles in Web of Science No. of theoretical-conceptual articles No. of empirical research articles No. of mixed methods articles
RQ2: What are the most cited articles?	Most cited articles
RQ3: What is the geographical distribution of the authors?	Countries of the first authors
RQ4: Which are the journals with the largest publications on this topic?	Q1, Q2, Q3 or Q4, ESCI, No rank Open Access
RQ5: How are digital transformation studies classified?	Customer Strategy Technology Operations Organization and culture
RQ6: What are the trends and topics addressed by the articles?	Technology models Digital pedagogies Open technologies Adaptive technologies Disruptive technologies Intelligent technologies

2. Search process

In phase 2, the search process considered the Scopus and Web of Science (WoS) databases, which cover many publications, the thematic areas, and the selected range of years (Mongeon & Paul-Hus, 2016). In the strings' construction, the Boolean operators, AND and OR, were used to integrate the selected variables. An iterative process with several tests was carried out to obtain the highest number of results in both databases (Kitchenham & Charters, 2007; Vial, 2019). Table 4 shows the strings and search terms applied on October 23, 2020.

Table 4. Search strings in *Scopus* and WoS

Table 4. *Search strings in* Scopus *and WoS*

Search strings in Scopus	Search strings in WoS
(TITLE-ABS-KEY ((“digital transformation” OR “digital*”)) AND TITLE-ABS-KEY ((“university” OR “higher education” OR “tertiary education”)) AND TITLE-ABS-KEY ((“model” OR “framework” OR “system”)) AND TITLE-ABS-KEY ((“media literacy” OR “digital competenc*” OR “digital literacy”))) AND DOCTYPE (ar) AND PUBYEAR > 2014	TOPIC: ((“digital transformation” OR “digital*”)) AND TOPIC: ((“university” OR “higher education” OR “tertiary education”)) AND TOPIC: ((“model” OR “framework” OR “system”)) AND TOPIC: ((“media literacy” OR “digital competenc*” OR “digital literacy”))

3. Inclusion and Exclusion Criteria

In phase 3, the inclusion and exclusion of publications criteria were defined considering they were indexed in the selected databases, related to the subject matter, and in the range from years 2015 to 2020. Those that did not meet the inclusion criteria were excluded. Also, papers and articles of previous access or review and those in publications not of high impact were discarded. Likewise, the publications’ language was limited to English and Spanish because these are the languages in which the researchers are fluent. The inclusion and exclusion criteria are presented in Table 5.

Table 5. *Inclusion and Exclusion Criteria* (own elaboration)

Inclusion criteria	Exclusion criteria
Studies indexed in the Scopus and WoS databases	Studies that do not address digital transformation
Studies on digital transformation and media literacy	Proceedings, papers or early access or review
Scientific articles	Articles that have not been published in high-impact journals
Articles published in high-impact journals	
Articles published during 2015-2020	Articles not published during 2015-2020
Articles on studies related to Higher Education	Articles published in Russian, German, Malay, Portuguese, Hungarian, Ukrainian
Articles on studies related to frameworks proposals	

4. Selection Process and Data Extraction

In phase 4, the articles were searched, then data extraction was performed, and then the information was input into an Excel database. The search resulted in 374 articles: 231 in Scopus and 143 in WoS. The information extracted from each article included the author(s), keywords, title, type of access, year of publication, name of publication source, number of citations, DOI number, affiliations, language, country, and abstract. Based on these data, 76 duplicate articles were identified and moved to another sheet of the database, resulting in 298 articles as review candidates. The missing information for each entry was then completed. Regarding the impact factor, 241 were found with an impact factor in Scopus and WoS, 46 in the Emerging Sources Citation Index (ESCI), and 11 with no rank. Figure 2 structures the delimitation based on the PRISMA method (Moher *et al.*, 2009).

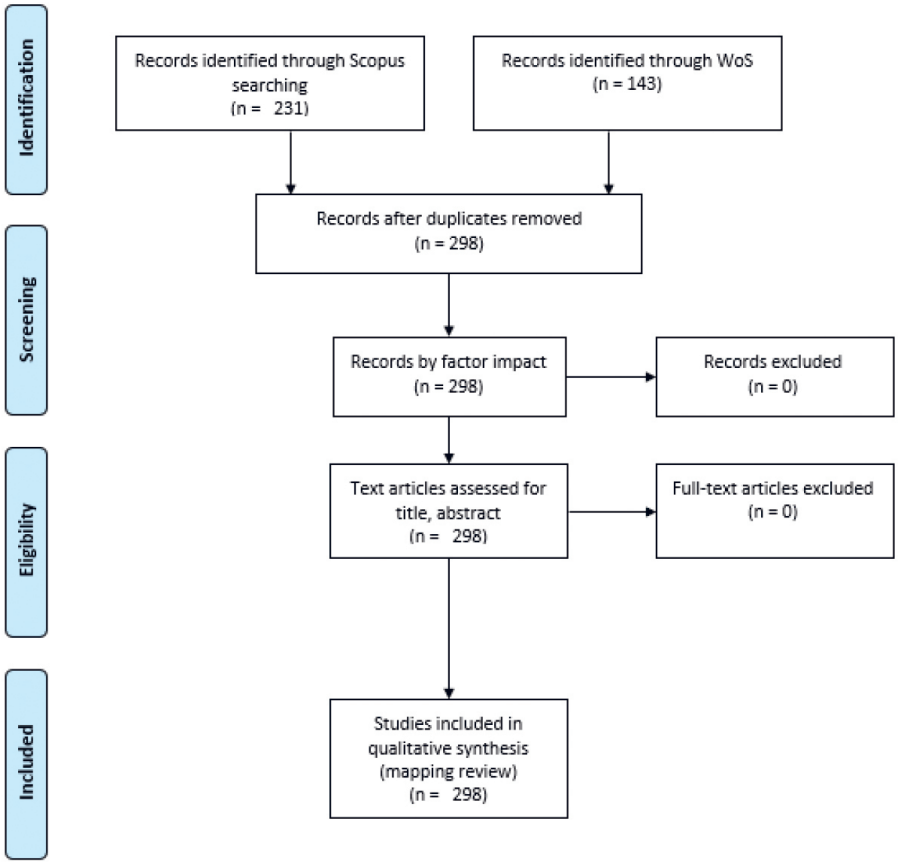

Figure 2. Selection Process

5. Data Synthesis

In phase 5, a classification was sought in the digital transformation subject to answer question RQ5, and the Digital Maturity Model (Anderson & Ellerby, 2018) focused on organizations was selected. Those categories are included in Table 1. The abstract's information, the keywords, and the article's title were reviewed to categorize each article.

Results

The systematic literature mapping methodology results documented in an Excel database were available at the following address: https://doi.org/10.6084/m9.figshare.14151563.

In this database, the information was organized to answer each research question.

RQ1 How many studies are in the Scopus and WOS databases between 2015 and 2020, and what is their design?

The number of articles that met the inclusion and exclusion criteria was 298; 77.5% were found in the Scopus database. Figure 3 shows 51.7% of the empirical research studies, which used qualitative research (MacLure & Stewart, 2018; Wang *et al.*, 2017), in-depth interviews (Önger & Çetin, 2018; Poncette *et al.*, 2019; Suwana F., 2017), or quantitative research. The latter was surveys applied to groups of students or teachers to approach the subject through case studies (Amhag *et al.*, 2019; Colas-Bravo *et al*., 2017; Khan & Bhatti, 2017; Miralles-Martínez *et al*., 2019; Munoz-Repiso & del Pozo, 2016; NIH Office of Behavioral and Social Sciences Research, 2018; Sánchez *et al*., 2017). Few studies used mixed methods; some opted to apply surveys and documentary or case studies (Tømte *et al*., 2015; Torres-Coronas & Vidal-Blasco, 2015; Villarreal-Villa *et al*., 2019).

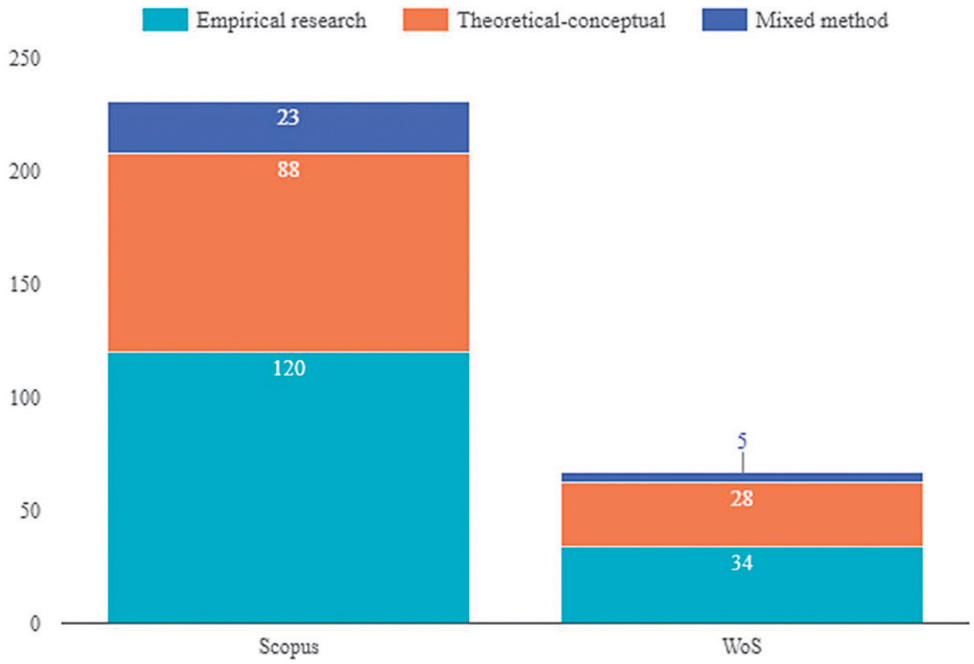

Figure 3. Number of articles by type of study.

RQ2 What are the most cited articles?

Analysis of the data showed one article had the highest number of citations (59) (Cronin, 2017). The article focuses on open education practices and the development of digital literacy. The second had 40 citations, (Murray & Pérez, 2015) which addresses adaptive learning issues and their impact on learning outcomes. Article with 39 citations (Tømte *et al.*, 2015) contributes to the study of online programs for teachers and digital competencies (see Table 5).

The topics of digital transformation and media literacy in higher education have shown interest since 2015. In 2019 and 2020, publications increased 23% and 50% over the previous year (see Figure 4).

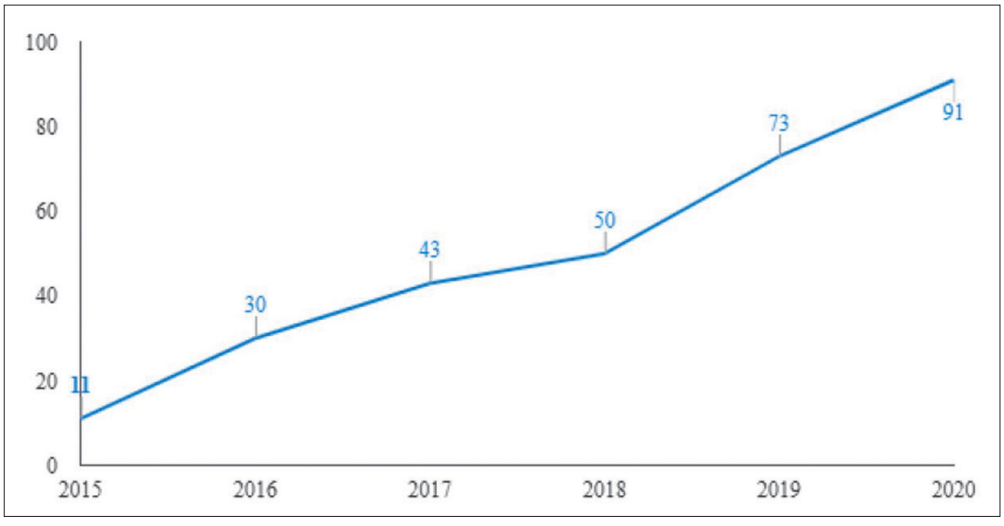

Figure 4. Number of publications per year

Table 5. Articles with the highest number of citations (own elaboration)

Number of citations	Identification number of the cited articles
59	255
40	296
39	291
34	287
31	208
26	193, 277
25	250
24	271, 290
22	292
20	294
18	195, 266, 293
17	142, 246, 281
16	136
15	210
14	217, 249, 278
13	283
12	253, 274
11	33, 183, 265, 268
10	192, 207, 211, 222, 227, 256
9	165, 173, 203, 223, 240
8	8, 40, 137, 189, 235, 238, 248, 264
7	112, 114, 251, 280, 285, 295
6	157, 191, 214, 245, 252, 259, 279, 288
5	54, 117, 126, 148, 166, 167, 186, 194, 215, 270, 272, 282
4	34, 70, 161, 205, 220, 236, 269, 289
3	48, 121, 122, 124, 134, 140, 144, 146, 147, 159, 164, 196, 202, 204, 216, 231, 233, 257, 267, 275
2	13, 22, 23, 31, 37, 46, 50, 74, 79, 106, 113, 119, 130, 145, 153, 163, 171, 181, 184, 185, 197, 199, 209, 213, 226, 228, 232, 234, 239, 241, 247, 258, 260, 284
1	4, 18, 19, 39, 47, 62, 66, 83, 96, 102, 110, 111, 115, 123, 125, 128, 132, 133, 135, 138, 139, 141, 143, 151, 152, 154, 156, 158, 160, 169, 170, 172, 176, 178, 180, 188, 190, 198, 212, 218, 219, 224, 263, 276, 298
0	1, 2, 3, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 20, 21, 24, 25, 26, 27, 28, 29, 30, 32, 35, 36, 38, 41, 42, 43, 44, 45, 49, 51, 52, 53, 55, 56, 57, 58, 59, 60, 61, 63, 64, 65, 67, 68, 69, 71, 72, 73, 75, 76, 77, 78, 80, 81, 82, 84, 85, 9

R3. What is the geographical distribution of the authors?

The first author's country of origin was used to identify the publication's geographical distribution. The authors' presence was found in 59 countries in five continents, evidencing the international research work on digital transformation and media literacy (Figure 5). Five countries accounted for 52% of the authors: Spain, the United States, the United Kingdom, Australia, and Russia (Figure 6). This data can be of value to locate researchers, networks, and institutions working on this topic to seek collaborations.

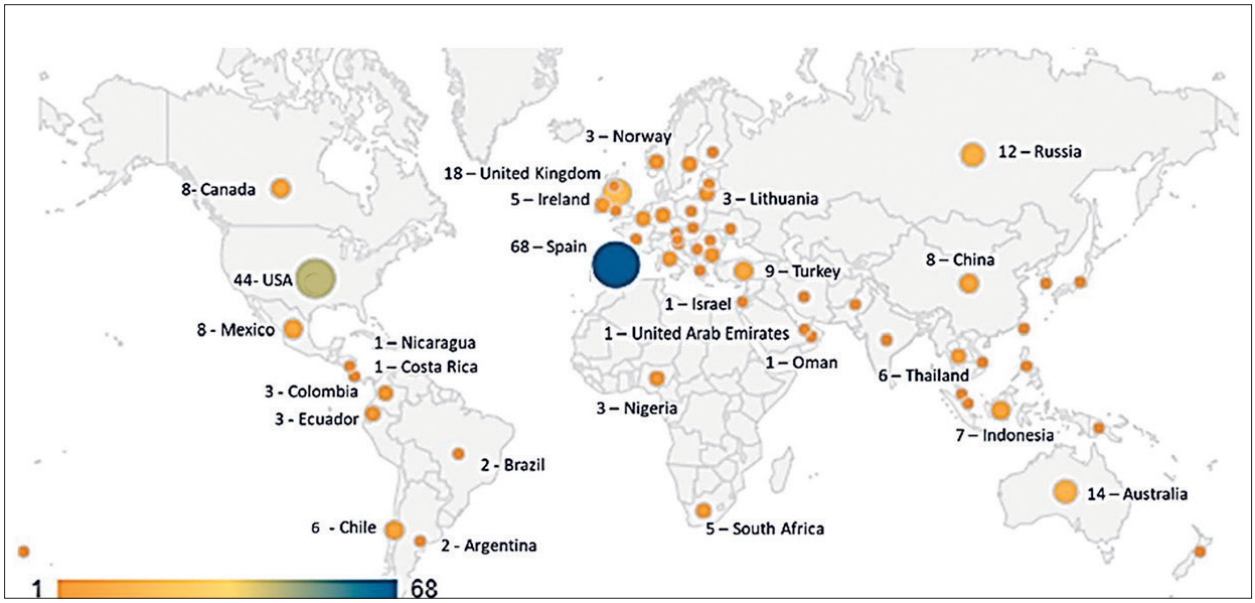

Figure 5. Geographical distribution of authors.

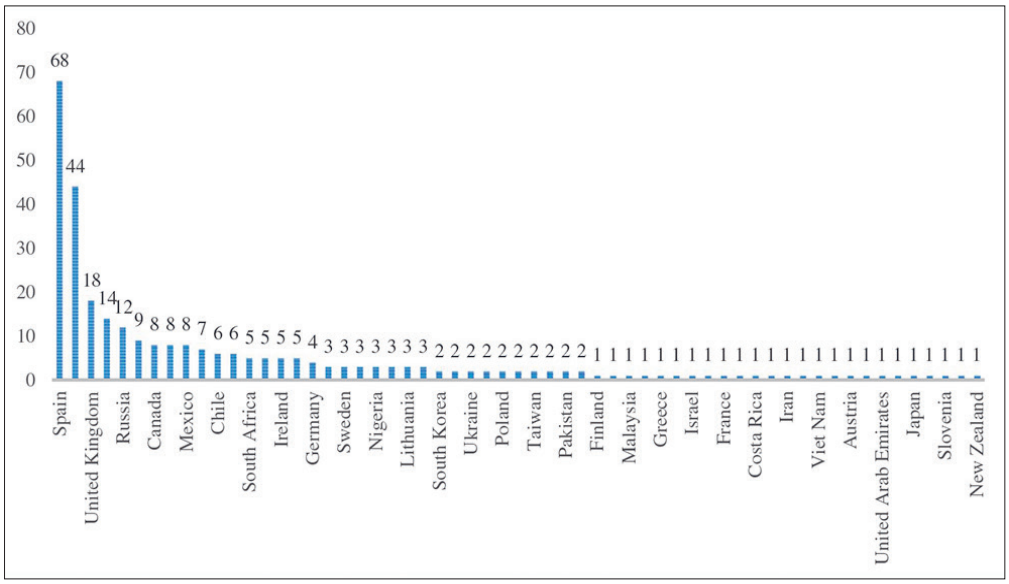

Figure 6. Frequency of publications by country.

Table 6. Journals with at least three articles (self-elaborated)

Journal	Database	Quartile	Number of articles	Article identification number
Journal of Adolescent and Adult Literacy	Scopus	Q2	14	11, 74, 181, 197, 212, 241, 243, 245, 257, 258, 269, 275, 283, 298
Sustainability	Scopus	Q2	8	7, 14, 16, 19, 22, 23, 130, 189
Research in Learning Technology	Scopus	Q2	7	75, 83, 170, 206, 280, 285, 294
Revista Latinoamericana de Tecnologia Educativa-RELATEC	WoS	ESCI	6	43, 90, 146, 173, 208, 210
Australasian Journal of Educational Technology	Scopus	Q1	5	47, 49, 51, 54, 172
Italian Journal of Sociology of Education	Scopus	Q4	5	132, 139, 246, 247, 248
Education Sciences	Scopus	Q3	5	3, 131, 138, 202, 204
International Journal of Educational Technology in Higher Education	Scopus	Q1	5	157, 191, 193, 235, 266
International Journal of Emerging Technologies in Learning	Scopus	Q3	5	76, 85, 147, 186, 251
Journal of the Australian Library and Information Association	Scopus	Q3	4	42, 46, 220, 264
Journal of Siberian Federal University - Humanities and Social Sciences	Scopus	Q3	4	57, 59, 152, 158
Electronic Journal of e-Learning	Scopus	Q2	4	84, 101, 267, 277
EDMETIC	WoS	ESCI	4	151, 153, 179, 198
Prisma Social	Scopus	Q3	3	73, 154, 162
Reference Services Review	Scopus	Q2	3	45, 128, 196
Reading Teacher	Scopus	Q1	3	111, 256, 270
Internet and Higher Education	Scopus	Q1	3	33, 34, 290
Computers and Education	Scopus	Q1	3	18, 268, 291
Comunicar	Scopus	Q1	3	161, 165, 167
International Review of Research in Open and Distance Learning	Scopus	Q1	3	234, 255, 281
Turkish Online Journal of Educational Technology	Scopus	Q3	3	237, 274, 297

RQ4: Which are the journals with the most publications on this subject?

The journals with the highest number of articles published on digital transformation and media literacy are shown in Table 6. Twenty-one journals with at least three articles were identified. The Journal of Adolescent and Adult Literacy stands out with 14 articles. 81% of the articles published were in journals with an impact factor. Of those articles, 48% were Q1 and Q2, and 19% were published in ESCI journals and without identified rank (see Table 7). This data may be of interest to support theoretical and conceptual frameworks on the subject, analyze different contextual practices, or make studies visible.

Table 7. Articles published in journals Q1, Q2, Q3, and Q4, ESCI, No rank (self-elaborated)

Quartile	Articles	Total
Q1	1, 2, 4, 5, 6, 18, 20, 21, 24, 33, 34, 35, 36, 39, 40, 54, 68, 77, 82, 94, 96, 105, 106, 111, 126, 137, 140, 142, 148, 157,161 165, 167, 172, 191, 193, 194, 209, 211, 217, 221, 233, 234, 235, 255, 256, 259, 263, 266, 268, 270, 271, 278, 281, 287, 290, 291, 293	58
Q2	7, 8, 11, 13, 14, 16, 19, 22, 23, 27, 37, 45, 47, 49, 50, 51, 55, 64, 65, 70, 71, 72, 74, 75, 83, 84, 88, 98, 101, 115, 116, 118, 128, 129, 130, 134, 135, 169, 170, 176, 178, 181, 184, 189, 195, 196, 197, 205, 206, 212, 213, 214, 216, 222, 227, 228, 230, 231, 240, 241, 243, 245, 249, 250, 254, 257, 258, 265, 267, 269, 272, 275, 277, 279, 280, 282, 283, 284, 285, 288, 289, 292, 294, 296, 298	85
Q3	3, 29, 30, 38, 42, 46, 48, 52, 57, 58, 59, 61, 66, 67, 73, 76, 80, 81, 85, 87, 91, 110, 113, 114, 120, 127, 131, 133, 136, 138, 143, 145, 147, 150, 152, 154, 156, 158, 159, 160, 162, 166, 182, 183, 186, 187, 188, 190, 199, 202, 204, 215, 218, 220, 223, 225, 226, 232, 237, 239, 244, 251, 252, 260, 264, 273, 274, 286, 295, 297	70
Q4	12, 15, 32, 63, 69, 92, 104, 108, 121, 123, 124, 132, 139, 141, 174, 175, 219, 224, 229, 236, 242, 246, 247, 248, 253, 261, 262, 276	28
ESCI	10, 17, 28, 31, 41, 43, 56, 60, 62, 78, 79, 86, 89, 90, 93, 95, 97, 100, 102, 107, 109, 112, 117, 119, 122, 125, 144, 146, 149, 151, 153, 155, 163, 168, 171, 173, 177, 179, 180, 185, 192, 198, 200, 203, 208, 210	46
No rank	9, 25, 26, 44, 53, 99, 103, 164, 201, 207, 238	11

RQ5: How are digital transformation studies classified?

Nearly half of the publications (42%) focused on innovation issues associated with business strategy, including incorporating new learning practice designs (Ting, 2015). 26% were research studies on teaching staff training (Creswell, 2014; Cronin, 2017; Tømte *et al*., 2015) classified in organization and culture, and 27% referred to the student's experience (Bond *et al*., 2018) in the customer category. The remaining 5% was made up of the category of technology in mobile learning (Bates *et al*., 2017) and operations with new processes (Wanotayapitak *et al*., 2019) (see Figure 7).

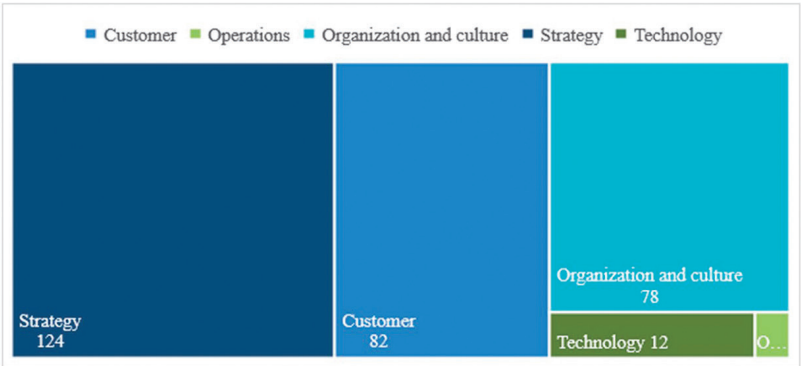

Figure 7. Classification of digital transformation studies.

RQ6: What are the trends and issues addressed in the articles?

Most of the studies (75%) referred to pedagogies that evaluate digital transformation elements and their impact on users' digital skills. 18% were conducted on using adaptive technologies that "adapt to society's needs and promote learning" (González-Pérez *et al*., 2019, p. 24), such as the use of Web 2.0 resources and applications (Guillén-Gámez & Mayorga-Fernández, 2020). Open technologies, which "enable open access for the dissemination of knowledge" (González-Pérez *et al*., 2019, p.24) include open education practices (Cronin, 2017). Others are smart

technologies that use mobile learning (Bates *et al*., 2017) or disruptive technologies that "involve new processes or services that generate structural or functional changes" (González-Pérez *et al*., 2019, p. 24). These include the use of extended reality in education (see Figure 8). Technological models is another category referred as "those that integrate innovation models with technology, such as smart innovation system, research-based design" (González-Pérez *et al*., 2019, p.24) and include geo-spatial referencing (Appel, 2019). The interest in applying trends in education is evidenced by the diversity of studies conducted during 2015-2020.

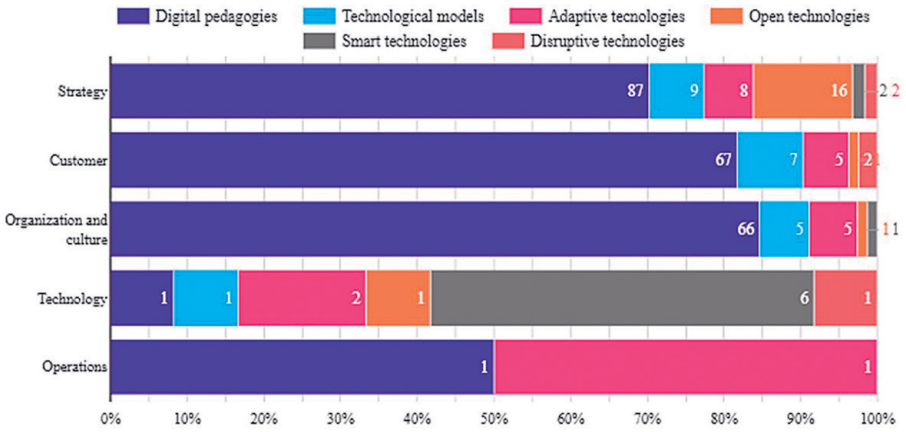

Figure 8. Trends and issues addressed by the articles.

Discussion

Scientific production on digital transformation and media literacy in the context of higher education institutions is a topic of interest among researchers. The results of this study indicated that empirical and conceptual-theoretical studies predominate over mixed studies, and that the Scopus database contains the largest number of articles (Figure 3). The search strategy for systematic reviews requires defining the primary sources of information appropriate to the object of study (Kitchenham & Charters, 2007); moreover, the identification of methodological approaches guides researchers in taking up or exploring new studies (Ramírez-Montoya & Lugo-Ocando, 2020). Formal research provides the basis for results that support decision-making in teaching practice, as well as in the strategy of educational institutions.

Digital transformation and its impact on media literacy are topics of interest for higher education institutions, both for its influence on learning processes and on the operation of the institution. In this research, the interest is evident in the increase of publications in the last five years (Table 5), as well as in the citations of the articles (Figure 4), with the topics of the three most cited articles being digital literacy, adaptive learning, and digital competencies of teachers (Figure 5). The adoption of new technologies in higher education ranges from electronic means of communication to platforms for delivery of learning resources, as well as systems that advance administrative processes (Sjöberg & Lilja, 2019), this demands that teachers and students develop new competencies to also evolve the teaching-learning process and be prepared for the demands of the work environment (Jackson, 2019). Technology works as the engine of innovation; its advances and new proposals, adapted to each context, generate new knowledge to learn, as well as new ways of learning.

In the last five years, publications on transformation and digital literacy experiences have come from authors in 59 countries. The results show the distribution of papers in five continents (Figure 5), which represents an opportunity to establish networks among researchers, so that the lessons learned from the most experienced can contribute to the development of countries that are just starting out. The country with the most publications was Spain, followed by the United States, the United Kingdom, Australia, and Russia (Figure 6). International initiatives such as the "Working Group on education: Digital skills for life and work" provide the current state of the UN member countries, as

well as the challenges to be met in order to make effective use of digital technologies in the classroom and in the workplace (UNESCO, 2017). Countries and higher education institutions must incorporate new technologies into their strategies and prepare for the changes that these technologies imply in processes, business models and the development of user skills.

Dissemination of research findings provides an opportunity for society to learn from the experiences of others. This study found publications that have incorporated digital transformation and literacy into their subject matter and have published up to 14 articles (Table 6 and Table 7); the journals are in the Q1, Q2 and Q3 quartiles, and in ESCI journals both in the Scopus database and in Web of Science. Scientific rigor and adherence to guidelines and standards facilitate the replicability of studies; it is important to select specialized databases, as well as journals and papers that have processes to ensure the quality of the studies (Kitchenham & Charters, 2007). Higher education institutions are considered the traditional sources of knowledge, and it is therefore important that they make it available to society.

Digital transformation has shown a systemic reach in organizations, mainly in key areas over the last five years. Most of the publications reviewed focused on strategy, customer, and organizational and cultural issues (Figure 7), which in relation to a higher education institution are associated to innovation in learning practices, student experience in mastering digital competencies, and faculty digital competency training, respectively; to a lesser extent, studies were found on technologies and processes (Figure 8). The development of digital competencies of both teachers and students contributes to the adoption of new technologies that support the learning process (Blau *et al.*, 2020; Bond *et al.*, 2018; Mendieta Baltodano, 2016; Reyna & Meier, 2018); in addition, educational institutions must generate strategies that ensure a systemic digital transformation so that their services and processes evolve at the same pace (Salmieri, 2019). The incorporation of technologies must be accompanied by strategies that favor their adoption by users and employees, the adaptation of processes and operations, as well as the incorporation of innovation practices on a permanent basis.

Technologies adapted to the educational context enable diverse alternatives that demand and promote the development of digital literacy. The results show trends that are grouped into six categories (Figure 8), where digital pedagogies that assess elements of digital transformation and their impact on the digital competencies of students and teachers stand out over the other categories. The incorporation of devices, as well as new forms of interaction moved organizations to rethink their processes and incorporate them to adapt to change (Schallmo *et al.*, 2017); as a result, educational institutions have recognized the opportunity provided by technologies and today they are part of most classrooms and educational programs. (Bucea-Manea-Ţoniş *et al.*, 2020; Liu *et al.*, 2020). Even so, it is important to keep in mind that technologies are a means to support the learning process, teachers must define the best way to incorporate them in their classes so that students are prepared for the changing work environment.

Limitations

This study analyzes trends and innovations associated with various emerging technologies in a specific period. It can serve as a reference and starting point for further research. The mapping was done using two indexing systems (Scopus and Web of Science), so future research can expand to other systems and digital databases.

Conclusions

Digital transformation has become a constant, opening numerous possibilities to enrich the educational experience. This research presents trends in digital transformation and digital literacy studies in higher education institutions, and it has even become a topic of interest for governments (Khitskov *et al.*, 2017; Rampelt *et al.*, 2019; Vasilev *et al.*, 2020; Xiao, 2020). As demonstrated in this literature review, educational institutions have adopted digital transformation in various areas of their businesses, including education and services to students, the adoption or creation of new technological applications, and initiatives to change organizational culture. This transformation occurs at the level of processes and systems. It also affects the people in the institutions, requiring them to continuously update their skills, which is why digital literacy is a prominent topic in empirical studies. This research provides a perspective on digital transformation studies in higher education institutions and their internalization approaches. It may be of value to trainers, students, decision-makers, and researchers interested in transformation, educommunication, and educational innovation.

List of abbreviations
WoS: Web of Science
ESCI: Emerging Sources Citation Index

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Competing interests
The authors have no relevant financial or non-financial interests to disclose.
Availability of data and material
The systematic literature mapping methodology results documented in an Excel database are available at the following address: https://doi.org/10.6084/m9.figshare.14151563

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ANEXO II

Humanities & Social Sciences Communications
REVIEW ARTICLE
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Artículo. Digital Transformation and Digital Literacy in the context of complexity: Systematic Literature Review

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Abstract
The incessant change of technology generates new products and services, presenting multiple opportunities for the complex educational environment. Consequently, higher education institutions must be attentive to these changes to ensure that students have the knowledge and skills necessary for the work environment. This research aimed to identify studies related to digital transformation and digital literacy in higher education institutions through a systematic study of literature. The search resulted in 830 articles published in the *Scopus* and *Web of Science* databases from 2015 to 2022. Quality questions, inclusion and exclusion criteria were applied where 202 articles were selected for the study. The results show (a) interest of educational institutions in empirical studies where technologies are incorporated for didactic purposes, (b) challenges of opportunity in training programmes to develop digital competences of teachers and students, (c) little interest in the development of media literacy, (d) the methodological aspects of the studies allow exploring new perspectives of digital transformation in higher education. This article may be of interest to academics, decision-makers and trainers of future professionals to introduce educational technology into learning processes in line with the complex demands of the world of work and society.

Keywords
digital transformation; educational innovation; higher education; media literacy; complex thinking; systematic literature review

1. Introduction

At the end of the twentieth century, the emergence of the internet led to organizations' digital transformation from analogous to digital information ("digitization"), followed by the incorporation of information technologies into business processes ("digitalization") (Verhoef *et al*., 2019). Several authors make no distinction between digitalization and digital transformation (Hess *et al*., 2016; Tratkowska, 2020; Xiao, 2020). Verhoef *et al* (2021) propose that digital transformation goes further; its impact generates new business models and value creation. Organizations' various areas are influenced and committed to change to remain relevant (Anderson & Ellerby, 2018). For this study, the term "digital transformation" (DT) was used.

Higher education institutions, in particular, must be attentive to the changes in the environment and society to ensure that students have the knowledge and skills demanded. Morin (2019, 2020) invites us to think of complexity as a challenge of contemporary thinking, which requires

a reform of our way of thinking, since classical scientific thinking was previously built on three foundations: order, separability and reason, but developments in science have undermined these foundations. In this sense, high-level competences such as reasoning for complexity become indispensable in the formation of critical, systemic, scientific and innovative thinking (Ramírez-Montoya *et al*., 2022; Vázquez-Parra *et al*., 2022). Complex environments require active (Patiño *et al*. 2023), collaborative (Romero-Rodríguez *et al*., 2022), open education (Suárez-Brito *et al*. 2022) and digital technology systems (George-Reyes *et al*., 2023, Ponce *et al*., 2022). Because of this, education systems around the world have made various efforts to address the influence of digital technologies and DT, such as UNESCO's 'Working Group on Education on Digital Skills and Work' (UNESCO, 2017), the "Bologna Digital 2020" report in Europe (Rampelt *et al*., 2019), the "Outline of China's National Plan for Medium and Long-term Educational Reform and Development (2010–2020)" of the Chinese government (Xiao, 2020), and the Digital Educational Agenda ADE.mx in Mexico (SEP, 2019). Likewise, this transformation has triggered the development of topics of interest that intertwine education with technology as proposed by González-Pérez *et al* (2019) (Table 1):

Table 1

Specific emerging issues in the use of educational technology

Categories
• Digital pedagogies: adapting pedagogical and technological resources to each area of knowledge. An example is b-learning, an environment with multimedia technologies.
• Technology models: integrating innovation models with technology, such as smart innovation systems and research-based design.
• Adaptive technologies: introducing new e-learning systems that adapt to the new needs of society and foster adaptive learning and educational systems (e.g., e-portfolios and Web 2.0).
• Open technologies: enable open access to disseminate open knowledge, including open platforms, repositories, open resources, MOOCs, and open science.
• Smart technologies: using smart tools and devices, such as Big Data, data mining, data analytics, cloud technologies, cloud computing in educational contexts, and m-learning.
• Disruptive technologies: involving new processes and services with leapfrog technologies, such as augmented reality, sensory stimulation, abstract imagery, and virtual and remote laboratories.

Currently, skills performed in digital environments have been added to the basic skills performed in analog environments. Skills such as problem-solving and applying technology were derived from digital technologies (UNESCO, 2017). Digital literacy involves mastering software and hardware, development, analysis, and interaction with digital content (Chetty *et al*., 2018). In particular, media literacy, defined as the ability to access, analyze, and evaluate the power of images, sounds, and messages and communicate critically and creatively through available media (Silva *et al*., 2021), focuses on new digital media available to users. More than a decade ago, the European Union declared the need to promote media education in academic curricula "because it is the best way to know and critically value the contents, messages and formats of the media" (Aguaded, 2009, p.7). With technological development, users went from being just consumers to content producers as well (Romero-Tena *et al*., 2020). As new technology becomes available to users, it demands from them continuous learning and the development of digital skills.

Due to the above, it is worthwhile to research the use and impact of technologies in the educational field on the delivery of content, pedagogical practices, and evaluation and management of learning (Williamson & Hogan, 2020), as well as its impact on users, teachers and students. Systematic studies of related literature are scarce, during this investigation, we found four reviews ranging from 2000 to 2020; they focused on the development of digital skills of students (Starkey, 2020), or university professors (Bilbao Aiastui *et al*., 2021), on digital competence assessment processes and methods in higher education (Sillat *et al*., 2021), and one focused on media literacy (Manca *et al*., 2021). This study contributes to the subject by integrating digital transformation practices in education, as

well as studies on digital competencies of students and teachers, which are key roles of higher education institutions.

This article aims to identify recent studies (2015-2022) related to the issues of digital transformation and digital literacy in higher education institutions through a systematic study of literature. This study can serve as a basis for higher education institutions interested in exploring educational innovations to identify these implementations and their outcomes and seek inter-institutional collaborations with common interests.

2. Methodology

The study was conducted through a systematic literature review (SLR) based on the guidelines proposed by Kitchenham and Charters (2007, p. 11), "a means to identify, evaluate and interpret relevant research on a particular topic". The phases to carry out the study were adapted from Kitchenham *et al*. (2010) and are described as follows:

- Phase 1 Planning: The research starts from the objective of analyzing studies related to the topics of digital transformation, digital literacy and media literacy in higher education institutions. A series of questions were defined to guide the review; these questions were derived from the integration of elements that would contribute to identify trends in digital transformation, research methods and instruments used in assessing such practices, as well as opportunities for future research; such findings would be useful to other researchers interested in the subject (Kitchenham and Charters, 2007) (Table 2).

Table 2
Research Questions

Research Questions	Possible responses
RQ1 What are the trends and topics addressed in the articles?	Digital pedagogies Technological models Adaptive technologies Open technologies Smart technologies Disruptive technologies
RQ2 What are the trends in research methods observed in the articles?	Mixed methods Qualitative method Quantitative method
RQ3 What are the main findings in digital transformation, digital and media literacy?	Content creation Digital skill level Educational technology
RQ4 What are the authors' recommendations for future studies?	Larger scale Literacy Longitudinal studies New instruments Technology
RQ5 What are the opportunities identified in the studies?	Training programs Use of educational technology Improving learning design Security & Privacy Open practices
RQ6 What are the stated limitations in digital literacy studies involving digital transformation?	Sample Feasibility Technological problems Instruments

- Phase 2 Execution: The articles were selected using inclusion criteria such as the publication period between 2015 and 2022, studies in higher education institutions, focus on students and professors, and empirical research or mixed studies. Articles not arbitrated or published in languages other than Spanish and English were excluded (Table 3).

Table 3
Inclusion, exclusion and quality criteria

Inclusion	Exclusion	Quality criteria
Studies in the Scopus and WoS databases.	Studies on subjects other than students or teachers.	Coherence between the objective, method, and results.
Studies in higher education institutions.	Studies in languages other than Spanish and English.	
Studies published between 2015-2022.	Conference papers, books, articles not arbitrated.	
Empirical or mixed studies.		

The search was conducted based on the above criteria in the Scopus and WoS databases (Table 4). 202 studies met the specified criteria (Figure 1).

Table 4
Search strings in Scopus and WOS

Scopus	WoS
TOPIC: ((“digital transformation” OR “digital*”)) AND TOPIC: ((“university” OR “higher education” OR “tertiary education”)) AND TOPIC: ((“model” OR “framework” OR “system”)) AND TOPIC: ((“media literacy” OR “digital competenc*” OR “digital literacy”))	“digital transformation” OR “digital*” (Topic) AND “university” OR “higher education” OR “tertiary education” (Topic) AND “model” OR “framework” OR “system” (Topic) AND “media literacy” OR “digital competenc*” OR “digital literacy” (Topic) and Article or Review Article (Document Types) and English or Spanish (Languages)

- Phase 3 Results: The results of each research question were analyzed to determine the state of the issues in digital literacy, media literacy and digital transformation and the scope of the proposed objective.

3. Results

Results are presented based on the research questions. For data analysis, Excel and Power BI were used. The database is available at the following link: XXXX**.**

3.1. RQ1 What are the trends and topics addressed in the articles?

The trends identified were determined based on the emerging themes of educational technology by González-Pérez *et al*., (2019), highlighting digital pedagogies (166 articles), which “link pedagogical and technological supports to adapt to each area of knowledge” (González-Pérez *et al*., 2019, p. 189). Examples include implementing the “blended learning” strategy (Power & Kannara, 2016; Tang & Chaw, 2016; Wang *et al*., 2022) and studies on digital skills (Ting, 2015; Tømte *et al*., 2015; Torres-Gastelú *et al*., 2019) and media competencies (Koc & Barut, 2016; Jormand *et al*., 2022) Second place went to adaptive technologies (21 articles) that “introduce systems that adapt to the needs of society and encourage learning” (González-Pérez *et al*., 2019, p. 189). Examples are the use of Web 2.0 tools (Sichel *et al*., 2019),

e-portfolio (Carl & Strydom, 2017), eLearning (Divya & Mohamed Haneefa, 2018; Feriady *et al*., 2020), adaptive systems (Murray & Perez, 2015), and social networks (Amaro-Jimenez *et al*., 2016; Robles Moral & Fernández Díaz, 2021)

To a lesser extent, the rest of the trends were found in 6 articles on technological models (Andrew *et al*., 2018; Bond *et al*., 2018; Kör *et al*., 2017) and open technologies (Cronin, 2017; Paskevicius & Irvine, 2019; Spieler *et al*., 2020). Finally, there were articles on disruptive technologies that use extended reality resources (Astudillo Torres, 2019; Bucea-Manea-Ţoniş *et al*., 2020) and smart technologies for mobile learning (Pinto Molina *et al*., 2019) (Figure 2).

The analysis of the author's keywords highlighted the issue of digital competence and digital literacy (de Ovando Calderón & Jara, 2019; Liu *et al*., 2020; Oria, 2020) and, to a lesser extent, digital teaching and media literacy (Tetep & Suparman, 2019; Sánchez-Caballé & Esteve-Mon, 2022) Also notable were keywords regarding technology in these topics (Roa Banquez *et al*., 2021; Rodríguez-Hoyos *et al*., 2021) (figure 3).

3.2. RQ2 What are the trends in research methods observed in the articles?

Studies on digital literacy, media literacy and digital transformation increased in the last three years; in 2022, it rose 53% compared to the previous year. The most commonly used research method (56%) was quantitative (Guillén-Gámez & Peña, 2020; Kim *et al*., 2018; Miguel-Revilla *et al*., 2020). Qualitative methods were found in similar proportions (Kajee, 2018; Önger & Çetin, 2018), and mixed methods (Pozos Pérez & Tejada Fernández, 2018; Techataweewan & Prasertsin, 2018) (Figure 4).

Also, the highest number of articles was found in Spain, which represents 32% of the total, and shows an interest in digital transformation and digital literacy issues in higher education institutions; followed by Turkey with ten, the United States with nine, and Chile, China and Mexico with seven research papers each (Figure 5).

3.3. RQ3 What are the main findings in digital transformation and digital literacy?

The principal findings center on studies on the level of digital skills, and use of educational technology (Figure 6). The most significant number of articles (121) focuses on digital competency (Blayone, 2018; Hong & Kim, 2018; Torres-Coronas & Vidal-Blasco, 2015; Zhao *et al*., 2021). The use of educational technology involves 2.0 technologies (Novakovich, 2016), virtual communities (Robin Sullivan *et al*., 2018), online education, or eLearning (Aznar Díaz *et al*., 2019; Hamutoğlu *et al*., 2019; Gumede & Badriparsad, 2022). Regarding media literacy, it was found in eight articles (Altamirano Galván, 2021; Brown *et al*., 2016; Koc & Barut, 2016; Jormand *et al*., 2022; Leier & Gruber, 2021; Olivia-Dumitrina *et al*., 2019; Reyna & Meier, 2018; Robles Moral & Fernández Díaz, 2021). Two additional issues identified were environmental protection (Amador-Alarcón *et al*., 2022) and educational process (Makarova *et al*., 2021) both of interest to today's situation faced by higher education institutions.

3.4. RQ4 What are the authors' recommendations for future studies? And RQ5 What are the opportunities identified in the studies?

By correlating these two questions, we identified four opportunities regarding digital literacy, digital transformation and media literacy (Figure 7); first, that higher education institutions have training programs for both students and teachers to help them develop digital skills (Igbo & Imo, 2020; Martzoukou *et al*., 2020; Sandí Delgado, 2020), media skills (López-Meneses *et al*., 2020; Reyna & Meier, 2018; Romero-Rodriguez *et al*., 2016), and critical thinking (Kocak *et al*., 2021; Nagel *et al*., 2022; Vetter and Sarraf, 2020). Second, that the development of skills requieres to enhance learning design by incorporating new didactic strategies, and educational technologies in academic programs (Boulton, 2020; del Prete & Almenara, 2020; Foster, 2020; Liesa-Orús *et al*., 2020; McGrew *et al*., 2019), and that the impact of these changes improves learning (Castellanos *et al*., 2017; Dafonte-Gómez *et al*., 2018; Sosa Díaz & Palau Martín, 2018).

On the other hand, methodological recommendations for future studies included incorporating new instruments and variables to collect more information (Kamardeen & Samaratunga, 2020; Khalil & Srinivasan, 2019; Varga-Atkins, 2020; Vetter & Sarraf, 2020). Others pointed to increasing the sample size (Amhag *et al*., 2019; Kolodziejczyk *et al*., 2020; Munoz-Repiso & del Pozo, 2016; Pozo-Sánchez *et al*., 2020). To a lesser extent, longitudinal studies were recommended to test the models used (He *et al*., 2018; Johnston, 2020). In addition, we found that 28% of the studies did not include recommendations, and 31% did not include opportunities for future studies.

3.5. RQ6 What are the stated limitations in digital literacy studies involving digital transformation?
The limitations indicated in the studies refer primarily to the small sample size (45%) (Arango *et al*., 2020; Romero-Tena *et al*., 2020; Tugtekin & Koc, 2020). To a lesser extent, limitations were found with the instrument used to carry out the study (Heuling *et al*., 2021; Nikou & Aavakare, 2021; Sánchez-Caballé & Esteve-Mon, 2022). Problems with the technology used was another limitation highlighted in eight studies (Castellano, 2016; Pozo-Sánchez *et al*., 2020). Finally, seven studies reported limitation regarding its feasibility (Dafonte-Gómez *et al*., 2018; Fázik and Steinerová, 2020; Kerr *et al*., 2019) and one on the low response obtained (Myyry *et al*., 2022); 36% of the studies did not include limitations (Figure 8).

4. Discussion

Incorporating new technologies in the educational environment has highlighted the need to continue developing skills that allow their adoption by teachers and students. The interest in digital pedagogies and the study of digital competencies are relevant among higher education institutions aiming to use adaptive, intelligent, open, or disruptive technologies and technological models (Figure 2). The transition from the analog to the digital world in both processes and products of organizations is part of their journey towards digital transformation (Hess *et al*., 2016; Tratkowska, 2020). It also includes organizational and cultural changes among users and operators (Anderson & Ellerby, 2018). However, we must point out that technology is not the end in itself but should be a means to facilitate learning.

Therefore, studies employing the scientific method where the benefit can be determined are relevant, and those that examine areas of opportunity by adopting technologies in the learning process. In the last three years, empirical studies on incorporating educational innovations in teaching practice in higher education institutions increased, most applying mainly quantitative methods (Figures 4 and 5). Spain is the country that stands out with the most studies (64). In some cases, the impetus for these efforts has come from the establishment of educational strategies at the national (SEP, 2019; Xiao, 2020) and regional level (Rampelt *et al*., 2019). These studies denote international interest in the influence of digital transformation, and digital literacy on the educational process.

Digital technology skills and knowledge are hallmarks of the twenty-first-century generations. Digital literacy and educational technology accounted for 95% of the study findings, and only 4% focused on media literacy. Required job competencies include software and hardware skills, critical thinking, information analysis, and the ability to create and communicate content (Chetty *et al*., 2018; Silva *et al*., 2021; UNESCO, 2017). This is an area of opportunity to continue research on the state of media literacy and its appropriation among teachers and students.

In addition to the conceptual components, the methodological aspects of the studies allow exploring new perspectives of digital transformation in higher education. In the studies reviewed, 44% of the recommendations concerned using new instruments, and explore new variables, while 56% were about sample size increase and longitudinal studies (Figure 7). Although they have not been conceived or designed for the educational field, the technologies are embedded today in the learning process (González-Pérez *et al*., 2019). Studies on their adoption allow testing and validating methodologies and instruments to have reliable data for their implementation (García-Ruiz *et al*., 2014). Although used simultaneously by teachers and students, the adoption of technology may require the implementation of different strategies or approaches to meet the needs of each group.

The ability to learn and unlearn is being tested by constantly introducing technologies into human activities. The opportunities reported by the studies coincide with the need for institutions to have training programs to develop skills for larger groups (27%). In the case of students, other topics of interest are the use of technology, enriched learning experiences, and security and privacy issues (Figure 7). Organizations' digital transformation strategy must consider the training of their members and their users because the skills required for the job become increasingly specialized (Anderson & Ellerby, 2018; Hess *et al*., 2016; Verhoef *et al*., 2019). In order to get the best out of educational technology, users are required to have a minimum level of digital literacy (Kerr *et al*., 2019). Higher education institutions are a fertile place to continue studies on digital transformation and the development of digital and media literacy of their members.

Therefore, empirical studies on the experiences and challenges faced by higher education institutions in adopting technologies in the learning process and strategies implemented to train teachers and students are relevant. The lim-

itations reported in the studies focused on methodological issues, with the sample size being the most crucial aspect to consider (45%). These studies were carried out in groups managed by the researcher, making it difficult to project the results. The systematic literature review methodology emphasizes the analysis of variables to answer research questions so that similarities and differences among studies can be identified (Kitchenham *et al*., 2010; Kitchenham & Charters, 2007). Inter-institutional collaboration can contribute to achieving results that help find joint strategies to promote the adoption of educational innovations and the development of competencies in both teachers and students.

Limitations

This study was limited to trends in higher education institutions in a specific period of time (2015-2022). Another limitation was the selection of two databases, Scopus and Web of Science, which although they include high-impact journals, articles from other databases were not considered; future research can continue the timeline and include other systems and databases.

5. Conclusions

The digital transformation of higher education institutions goes beyond its impact on administrative and operational processes. The study showed that teachers have incorporated new pedagogies and technologies for didactic purposes, and this has highlighted the need to develop the level of digital literacy of both teachers and students. Higher education institutions, as trainers of future professionals, must acknowledge this trend and act upon to develop strategies so students and teachers are prepared for the demands of the workplace.

The pandemic spurred the urgency of developing digital skills for both teachers and students. Technologies they used for socializing and leisure, became necessary tools for study and work. Although related empirical studies on media literacy were scarce, since it is linked to the use of technology, future studies have an opportunity to assess how it develops in the following years. These should examine teachers' and students' performance, their critical capacity as media users, and content creators.

The development of teachers' digital competencies involves not only the mastery of technology but also the improvement of their teaching practice with the appropriate pedagogical use of technology to contribute to student learning. Higher education institutions can make use of instruments for measuring digital competencies, some of which have been adapted to local needs, allowing them to identify strengths and opportunities to focus their training programs. The same applies to students, who should be provided with the relevant training for the development of digital skills, and prevent the lack of these from becoming an obstacle to their performance in the classroom.

This study aimed to identify the state of digital transformation and digital literacy in higher education institutions and their impact on students and teachers. Technological progress provides opportunities to enhance the learning process, and teachers' and students' digital literacy. Research must continue to assess the performance and students' gains. This study can serve as a basis for higher education institutions interested in exploring educational innovations to identify these implementations and their outcomes and seek inter-institutional collaborations with common interests.

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Competing interests

The authors declare no conflict of interest.

Data availability

The datasets generated during and/or analysed during the current study are available in xxx repository, [xxx].

Ethical approval / Informed consent

This article does not contain any studies with human participants performed by any of the authors.

ANEXO III

Journal of Interactive Media in Education
Collection: Microcredentials
Article
Ubiquity Press

Artículo. Educational Innovation with Alternative Credentials as a Driver of the Digital Transformation of the University: A Case Study in Latin America

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Abstract
The dynamics of change in the work environment are becoming more dizzying, given that adopting new technologies generates new knowledge and jobs. This research analyzed a case study of a Mexican university implementing alternative credentials. The method was instrumental case study research, with exploratory and descriptive categories, applying three instruments: documentary analysis of alternative credential programs, a questionnaire, and interviews with the experts involved in designing and delivering alternative credentials. In this case, the implementation of alternative credentials coincided with the reference frameworks of the European Union and the province of Ontario, Canada. Their frameworks mention the vision and institutional mission of alternative credentialing for the value offered, its definition, operation, award processes, accreditation, and quality. The case provides data for interested higher education institutions, such as why to do it, the strategy to follow, the added value offered, the elements that define it and its design, the assessment process and assignment, the timing of accreditation, and where it is recognized. This research contributes recommendations for defining and managing alternative credentials to serve as a reference for other universities interested in incorporating technology-supported educational innovations.

Keywords
Digital transformation; Alternative credentials; Higher Education; Educational Innovation; Organizational model; Case study

Introduction

Information technologies and the evolution of the work environment opened the way for the educational field to explore how to incorporate technologies in the learning process. Technology has challenged all industries because its functions enable processes rather than an end. Its adoption leads to organizational changes (Steiber *et al*., 2020). The pairing of education and technology drives the future of learning and talent development (HolonIQ, 2021). At this time in humanity, the limits in the use of technology by industries are becoming more tenuous, and the education sector is included through the digital transformation of its processes and practices of educational innovation.

This research first presents the literature review, case study context and the research method. Next, the literature review results are described and discussed. Finally, conclusions are presented with recommendations for those institutions interested in exploring the implementation of alternative credentials. The article is of value to educational and innovative communities interested in new training options, such as alternative credentials.

Conceptual framework

Educational innovation and digital transformation

Digital transformation in the work environment has caused jobs to evolve faster. Organizations have seen the need for a workforce capable of developing and implementing new technologies in the short term (Kane *et al*., 2017). Consequently, universities must incorporate new technologies into their programs to prepare their graduates (Guillén-Gámez *et al*., 2020). Likewise, they must consider, assess, and incorporate trends such as augmented and virtual reality, technology platforms, and artificial intelligence, which have been present in the panorama of higher education in the last five years (Table 1).

Table 1

Top Higher Education Technology and Business Trends for 2021

Student experience	Sustainability	Scaling the change	New Normal
• Alternative credentials • Corporate collaboration • E-Sports • Virtual experiences • Cross-Life-Cycle CRM	• Enigmas of enrollment • Tuition tensions • International students • Low-Code applications • Cyberthreats	• The changing role of the CIO • Online everywhere • Cloud now • Chatbots • Hybrid classrooms	• Online productification • COVID-19 campus • Hybrid everything • Remote proctoring • Faculty Info. Systems

Note. Taken from Morgan *et al*. (2021)

Training throughout life has become a constant in the professional development of people. As of 2013, Gartner included open credentials as an educational trend with the emergence of the Massive Open Online Course (MOOC) (Lowendahl, 2013), and in 2018 it renamed them digital credentials (Calhoun Williams, 2018). MOOCs have been an option for developing knowledge and skills in less time than traditional formal education programs for undergraduate or graduate degrees. In this regard, the Coursera an d edX impact reports highlight that 87% of MOOC learners progress in their career path (Coursera, 2020; edX, 2020). Due to the above, universities and organizations with training programs displayed these credentials, highlighting areas of opportunity in terms of implementation and clarity of purpose for the end user.

Alternative Credentials Overview

The addition of credentials as a new educational product resulted in rapid adoption by people looking for a solution to their training needs. However, it also triggered a global market that has made it challenging to establish equivalencies, quality standards, and official recognition that is useful for both users and employers (Erasmus+ Programme, 2019). For example, in the United States, 738,428 different credentials were identified (Credential Engine, 2019). Another aspect to consider is the lack of consensus on the meaning and scope of this product (Table 2). These situations revealed areas of opportunity to achieve harmonic and systemic incorporation of this educational trend.

Table 2

Concepts related to alternative credentials

Attribute	Concept	Description
Duration	Micro-credential	Digital certification proves that an individual has mastered a specific skill (Tecnologico de Monterrey, 2019, p.27). Evidence of the learning outcomes that a learner has acquired through a short learning experience. The results have been evaluated against established standards (European Commission, 2020). These are typically focused on a specific set of learning outcomes in a narrow field of learning and achieved over a shorter period of time (UNESCO, 2022, p. 20).
Duration	Macro-credential	Understood as traditional academic degrees (Chakroun & Keevy, 2018). They indicate learning achievement of a broad body of knowledge, transferable skills or technical proficiency and may take a number of years to complete (UNESCO, 2022, p. 20).
Delivery	Digital badge	It provides a visual record of achievement, can be shared via social media and professional sites, and is added to a digital and physical portfolio (Dyjur & Lindstrom, 2017).
Delivery	Digital credential	Certification granted by an institution that includes the person's data and reliably communicates the authenticity of its content and the description of the recognition, which cannot be modified or altered (DCC, 2019).
Type	Alternative credential	It refers to those competencies, skills, and learning outcomes that derive from activities unrelated to a professional title or degree (Tecnologico de Monterrey, 2019, p.24). Those that are not recognized as formal educational certifications per se by competent national educational authorities (Kato *et al*., 2020).
	Credential	Verify, validate, confirm, or corroborate a person's learning achievements, knowledge, and preparedness for performing tasks (UNESCO, 2022, p. 20).

Note: self-elaborated.

Table 2 identifies the terms "micro" and "macro" used to distinguish between credentials based on their duration. This way, the term micro is assigned to courses such as MOOC, certificates, nano-degrees, and Micro-Masters, and to learning experiences as coding boot camps and apprenticeships, whose study could be three days to nine months (McGreal and Olcott, 2022). On the other hand, the term macro is used for academic degrees as well as diplomas, and licenses lasting from two to five years. The term "digital" has been added to distinguish the technological means of delivery from its traditional counterpart in paper forms. Finally, the term "alternative" is applied to distinguish these from

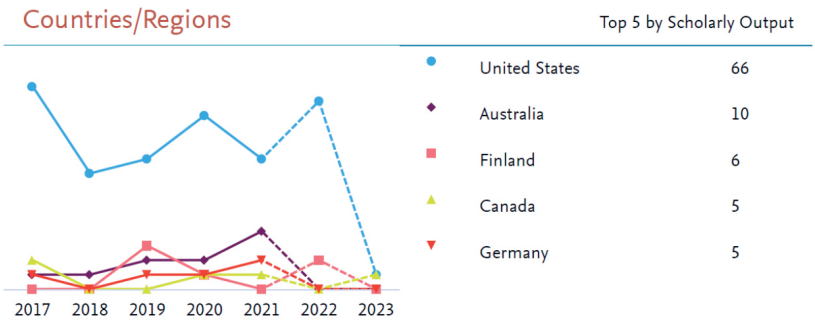
traditional credentials, either by their duration or delivery method, which, like their counterparts, also aim to recognize acquired knowledge and/or skills. UNESCO (2022) proposes credential, a broad, umbrella, term to facilitate its adoption among the different sectors and stakeholders. The term "alternative credential" is considered for this work because it intends to go beyond the digital delivery format. Although digital credentialing has become more common as organizations transform their processes, the delivery medium will no longer be considered a difference in the future (Figure 1).

Figure 1
Credential keyword analysis

Note. Source: Scopus, 2023.

Scientific production with alternative credentials predominates in the United States, Australia, and European countries (Figure 2). Below are examples of alternative credential implementation in Europe and the Americas.

Figure 2
Main countries/regions with scientific production



Note: Entity: Credentialing; Education; Instructional Design T.60840·Year range: 2017 to 2023 ·Data source: Scopus, up to 25 Jan 2023.

The need for reskilling and upskilling is advancing at the same speed as the development of new technologies, and alternative credentials are seen as an option to fulfill this demand. The main drivers of change in alternative credentials have derived from the fourth industrial revolution, changes due to the digital transformation of education, and the globalization of labour markets (Cedefop, 2022). As a result, in 2020, the European Union published the Bologna Digital Agenda and the "Digital Education Action Plan," with which it put its hands to work in its interest in

advancing the digitization of credentials (Hudak & Camilleri, 2018). As part of this strategy, in July 2020, it launched an initiative focused on implementing micro-credentials to be developed over four years. The framework includes defining micro-credentials, quality standards, accreditation processes, and the means of portability and dissemination (European Commission, 2020). To accomplish the above, they formed working groups with the participation of the member states and parallel projects that contributed with recommendations on implementing micro-credentials (Cirlan & Loukkola, 2020). Achieving consensus helps to advance adoption and transparency for those participating.

Decision making process and frameworks must keep pace with changes in the labour and technological environment. The Council of the European Union published in May 2022 a set of recommendations which "aimed to support the building of trust in micro-credentials across Europe among all those involved, whether providers or beneficiaries" (Council of the European Union, 2022, p. 4). These recommendations include definitions, descriptive elements of the credential, deployment of a design and implementation ecosystem among member states (Council of the European Union, 2022; van der Hijden and Martin, 2023). This strategy is also taking place in other parts of the world, such as Australia and America, although examples are found only at the national level.

Australia is an example of alternative credentials implementation at the country level. Their interest in having an alternative credentials' framework is to facilitate the learner's experience in selecting the right offer for their needs, as well as to be recognized by employers (Department of Education, 2021). As a follow-up to this strategy, the government intends to develop an alternative credentialing platform to connect providers and users (van der Hijden and Martin, 2023). Universities such as Griffith, Deakin and RMIT lead the credential offering with short-courses at graduate and undergraduate level (McGreal and Olcott, 2022). Establishing agreements facilitates the deployment of large-scale programs.

Alternative credentials have impacted educational institutions and government initiatives in the United States and Canada. The interest in credentials in Canada is recorded in Google searches before 2004 as digital badges and as of 2013 as micro-credentials (Brown *et al*., 2021). The Ontario government recognized the importance of this trend and allocated part of the 2020 budget to define a micro-credentials strategy to improve job skills (Pichette *et al*., 2021). Other advances in this direction have been alliances of higher education institutions with platforms for the delivery, management, and verification of digital credentials (Brown *et al*., 2021). In 2019 eCampusOntario published the Micro-credential Principles and Framework "which provides a common standard on which to collaborate and create micro-credential programming" (Gooch *et al*., 2022, p. 26). This effort has a local level outreach to develop a credential ecosystem.

In the case of the United States, the number of credentials was estimated at more than 330,000 in 2018, and a study published in 2019 found more than 730,000 unique credentials available (Credential Engine, 2019). Higher education institutions, such as the State University of New York, formed work teams to develop a micro-credentials implementation strategy to establish a definition that provides clarity to students and those who develop the content, as well as an approval process that ensures quality, flexibility, and delivery (SUNY, 2018). In addition, North American universities integrated the "Digital Credentials Consortium" in 2019 with universities from Europe and Latin America to create a trusted, distributed, and shared infrastructure that can be the standard for issuing, storing, displaying, and verifying digital academic credentials. (DCC, 2019). Both in Europe and America, it is clear that its implementation involves more than just adapting content; it is necessary to adjust management models, evaluation, dissemination, and recognition of alternative credentials in organizations.

This research is valuable because, although ten years have passed in which MOOC courses have boosted alternative credentialing, it continu es to be a little-explored topic. For example, from 2017 to 2023, 127 articles on this topic were published in Scopus journals worldwide (Scopus, 2023). Studies on the need to scale access to education and develop skills and knowledge for adults, and the challenges faced by consumers and providers (Cumberland *et al*., 2023; Delello and McWhorter, 2017; Selvaratnam and Sankey, 2021), higher education teachers (Dyjur and Lindstrom, 2017) and undergraduate students (Graham *et al*., 2023; Ward *et al*., 2022). Alternative credentials motivate learners and provide new paths to learning and recognition (Carey & Stefaniak, 2018; Mah, 2016). Thus, this paper aims to present the experience of a Mexican higher education institution in implementing alternative credentials and identifying best practices as a reference for those universities and organizations interested in venturing into this trend.

Context

Tecnológico de Monterrey is a private Mexican institution founded in 1943. It offers high school, undergraduate, and graduate academic programs to more than 90,000 students on 26 campuses in the Mexican Republic and has more than 10,000 teachers (Tecnologico de Monterrey, 2021). The institution has been a pioneer in the implementation of distance education programs for more than 30 years, both in academic programs and continuing education: 227,396 high school and undergraduate students have taken digital education courses, along with 35,000 graduates from online programs, 1.5 million online diploma professionals, and more than 1.5 million people in MOOCs (Tecnologico de Monterrey, 2022, p. 9). In addition, the university has stood out for incorporating educational technology in the learning process with innovations such as immersive learning, personalized learning, and hologram telepresence effect, impacting more than 30,000 students since 2018 (Tecnologico de Monterrey, 2022).

Likewise, Tecnologico de Monterrey was the first private Mexican university to associate with the Coursera platform in 2013, attaining more than 137,000 students from 142 countries enrolled in seven courses (Tecnologico de Monterrey, 2019). Based on this experience, it also associated with the edX and MéxicoX platforms, reaching more than 1.7 million subscribers (Tecnologico de Monterrey, 2019). These associations made it possible to explore new trends and venture into products besides MOOCs, such as the specialized programs of Coursera and Micro-Masters in edX (Tecnologico de Monterrey, 2019). In this way, it introduced alternative credentials for students to earn recognition for specific skills and knowledge, and as a flexible pathway towards a graduate degree (Jackson, 2019; Tecnologico de Monterrey, 2019; (Tecnologico de Monterrey, 2023; Treviño, 2020)).

Methodology

This research applied the qualitative instrumental case study method. The case study presents the detailed analysis of an event within a group or community where the researcher has little control over the phenomenon, which takes place in real life (Merriam, 2002; Yin, 2009). The case study focuses on a unit of analysis, a delimited system with particular characteristics (Merriam, 2002). In this research, the unit of analysis of a higher education institution was an instrument to know the configuration and application characteristics of alternative credentials.

Sample

The study sample consists of two professors, subject matter experts, and the lead for the design team (Table 3) involved in the development of a specialized program in Coursera for which students who pass and obtain the certificate have the possibility of requesting the accreditation of a subject from the Master's Degree in Educational Technology (MTE) or the Master's Degree in Education (MEE) of the Tecnologico de Monterrey.

Table 3

Participants' role

Participant ID	Role
PA	Subject matter expert
PB	Subject matter expert
PC	Design team leader

Instruments

Before data collection, planning was carried out to select the most appropriate strategies and instruments for this research. The qualitative method has three primary sources of information, interviews, observation, and documentary analysis (J. Creswell, 2014; Merriam, 2002). For this work, we chose interviews and questionnaires with subject matter experts responsible for designing and delivering the credentials, and documentary analysis of the implemented programs. In a qualitative case study, the questions may refer to a description of the case and the issues that arise when studying it (J. Creswell, 2014). In this study, the exploratory analysis elements were delimited to describe the characteristics of the alternative credentials; three

instruments were applied: interviews, questionnaires, and document analysis. The confidentiality and anonymity of the participants' opinions was guaranteed, and data was analyzed for academic and research purposes. The participants voluntarily agreed to participate in the study.

The questionnaires included open questions to inquire about the participants' experience implementing alternative credentials. The questions were grouped into five sections to answer the questions why (elements that guide the institution's strategy and business model), what (definition and aspects to consider in its design), how (assessment process and allocation), when (they are accredited), and where (portability and recognition by third parties). The 50-item questionnaires were sent to the experts by email, who answered them individually (Appendix 1).

The semi-structured interviews were applied individually to the same university experts, with open questions to deepen information about the five sections mentioned above. Interviews were conducted through the Zoom tool.

The institutional public documents (educational innovation documents and web pages) and alternative credential programs were analyzed, and the publication strategy of offering alternative credentials on commercial platforms, such as Coursera and edX, was reviewed. The characteristics considered to define the credentials and who would participate in their design, the evaluation elements, the accreditation process, and the publication and portability of the credentials offered to students were also reviewed.

Categories and data analysis

The data analysis was carried out by categorizing the responses from the questionnaire and the interviews based on the models of Pichette *et al*. (2021) and Hudak and Camilleri (2018) (Table 4). The thematic analysis allowed to take as a base the categories of the selected frameworks and identify new categories from the responses. The reason for selecting these frameworks was that they were aimed at higher education institutions, and the intention was to relate the case under discussion to the experiences of other universities.

Table 4

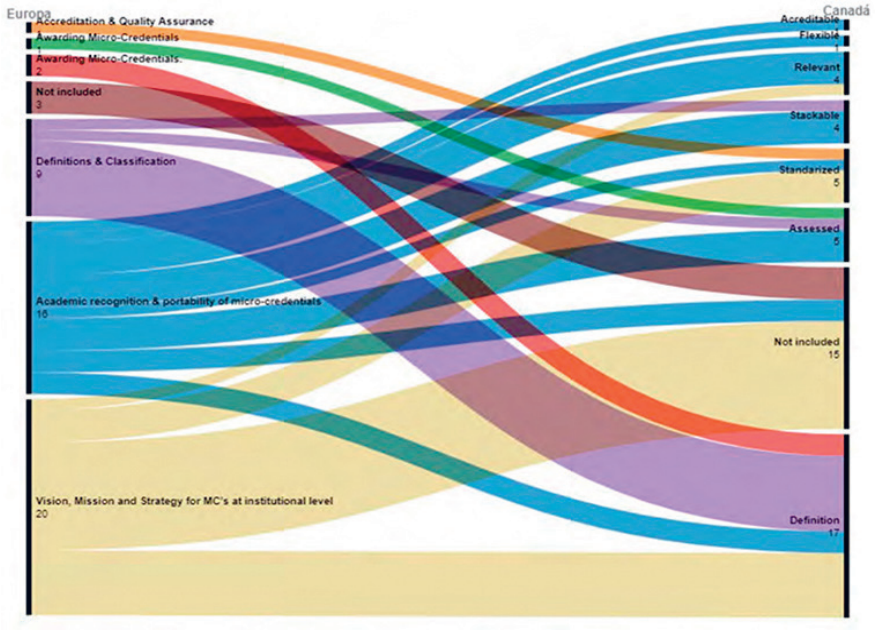
Information analysis categories

Micro-credentials Quality Markers for Postsecondary Institutions (Pichette *et al*., 2021)	he Micro-Credential (MCs) Users' Guide (Hudak & Camilleri, 20
*Definition	Definitions and Classification.
Relevant: Consulted or involved in industry/ community.	Vision, Mission, and Strategy for MCs at the institutional level.
Flexible: The pace and/or structure of learning can be personalized.	
Accredited: Recognized or issued by a professional accrediting body.	Accreditation & Quality Assurance.
Standardized: Meets a government-set quality standard.	Awarding Micro-Credentials.
Assessed: The learner must demonstrate skills/ knowledge to earn the credential.	
Stackable: Can be "stacked" or combined toward a higher credential, e.g., a diploma or degree.	Academic recognition and portability of micro-credentials.

The questionnaire analysis was carried out considering the categories of two frameworks, Pichette *et al*. (2021) of the province of Ontario, Canada, and Hudak and Camilleri (2018), concerning the European Union strategy. The instrument's questions were assigned to these two frameworks (not exclusively), with 94% being identified in Hudak and Camilleri (2018) and 71% in Pichette *et al*. (2021) (Figure 3).

Figure 3

Categorization of the battery of questions based on Hudak and Camilleri (2018) and Pichette et al. (2021)



The analysis characteristics of the reference frameworks were imposed upon the instrument items. It was found that more than 70% were related to these categories (Figure 3), which denotes the common interests and concerns among higher education institutions regarding the implementation of alternative credentials, such as having a definition, establishing evaluation and assignment processes, and ensuring that third parties recognize them as evidence of student development.

It is important to note that the issue of intellectual property on the content developed by the teacher was not found in the reference frameworks; however, it is an aspect to consider in the content design and understanding between the institution and the participating teachers.

Based on these results, the case study analysis categories were delimited to answer the questions described above (Table 5):

Table 5

Categories identified for case analysis

Questions	Categories
Why	Value added Institutional Strategy
What	Definition Flexibility Intellectual property
When	Accreditation
How	Evaluation and assignment process
Where	Recognition and portability

Ethical statement

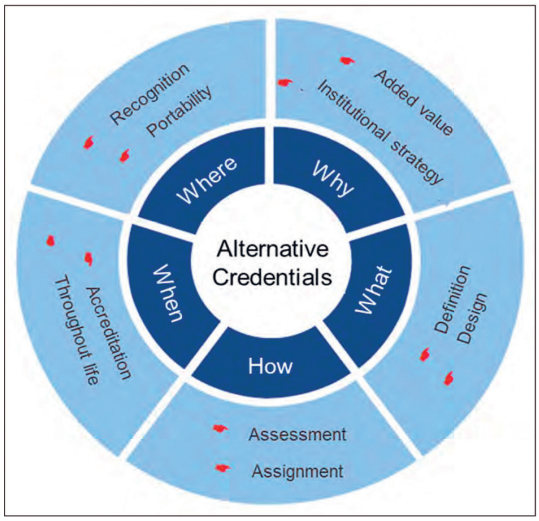
The ethical processes in the study addressed various ethical dilemmas (J. W. Creswell, 2007; Lincoln & Guba, 1985), such as the participants, data management, and dissemination of the generated knowledge. Before starting the fieldwork, we presented extensive and detailed information to the voluntary participants. The data handling was handled objectively, similar to the evidence collected in important public documents; as stated above the confidentiality and anonymity of the participants' opinions was guaranteed, and data was analyzed for academic and research purposes. The researchers analyzed the data of interest following the recommendations of Traxler (2012). The dissemination of knowledge must respect the participants' confidentiality and adhere to what is indicated in the investigation of the case study.

Results: a case of alternative credentials at Tecnologico de Monterrey

Next, the results obtained from applying the instruments were presented and grouped to answer the five questions: why implement digital credentials, what is considered a digital credential, how are they evaluated, when are they accredited, and where are they recognized (Figure 4).

Figure 4

Alternative credentialing components



Why? Added value, institutional strategy

Clarity in digital credentialing implementation is crucial for the educational institution. The participants declared that it is necessary to consider the value of the labor market, the value it brings to the students and graduates, and the hallmark it brings to the institution. Regarding the value it brings to the student, the credentials were used to review specific content or develop certain skills in undergraduate students and to incorporate new topics in graduate studies. Comments from participant A support these ideas.

> *PA: It is necessary to highlight the value it [the alternative credential] gives to the person, why the institution offers it, and what is the impact it has on the person who decides to seek and achieve it.*

The value brought to the graduate must be perceived in the labor market. In this way, the courses were designed to provide flexibility as they are optional graduate courses with a flexible schedule and reduced cost. Likewise, it was essential to document the business model for decision-making, which included the cost of content design, payments to designer teachers and tutors, and the publication strategy and management of the offering for which alliances were established with MOOC course platforms to reach a wider audience.

What? Definition, design

In the experience of the participants, in this case, the institution did have a process for the design and delivery of alternative credentials, where the interested department first documented a proposal aligned with institutional policies, as well as the added value of implementing credentials, such as opportunities for positioning and attracting students to graduate programs.

> *PB: The strategy decided was to offer a flexible program of the School of Humanities and Education, that is, elective courses, with a flexible calendar, and reduced cost.*

Once the Dean of the School authorized the proposal and business case, several areas were involved, including one that manages the MOOC provider platforms and the area that designs the centrally taught digital education programs. In this case, three teachers participated in the content design. The moral rights to the developed contents belong to the teachers and the patrimonial rights to the institution.

To design the credentials, a group of specialists in digital education was assigned to the teaching team. This group of specialists comprised specialists such as pedagogical architects and instructional designers, technologists such as programmers and Web developers, and creative personnel such as multimedia designers, graphic designers, and video producers and editors.

Before designing the credentials, the group defined the delivery modality, didactic structure, duration, methodology, evaluation, and educational resources to present the contents and promote learning.

> *PC: The online courses were designed with various educational resources such as video, readings, presentations, and immersive resources, to promote active learning*, and to help the student develop the required competence.

The participants stated that their didactic approach was determined by defining the credentials, the competencies to be covered, and the disciplinary area of the contents. This was done by the department interested in implementing credentials aligned with institutional policies. In this case, the purpose of the credentials was to find opportunities to position and attract students to a graduate program. The development time took between eight and twelve months for the teaching team and the team of specialists.

Likewise, they established the characteristics to consider within the digital credentials, which included learning objectives, the instructional methodology implemented, the evaluation model, and the duration of the credential, that is, the time that the student must dedicate to complete the contents and activities, which are the guiding axes for any course teaching modality.

Also, the development team highlighted that when designing credentialing for an online learning environment, these components need to be adapted to the environment, incorporating the functionalities of the platform and the technological resources used.

An issue that arose among the participants, which was not specified in the reference frameworks, regarded the intellectual property of the credentialed contents. They specified that the moral rights belong to the teacher in charge of their development, and the patrimonial rights correspond to the institution. Intellectual property was managed in the institution with agreements where teachers signed a copyright transfer for the work and projects entrusted during the employment relationship to the institution.

> *PB: Regarding the rights to use the material, a transfer of rights is signed by the subject matter experts with the university for an indefinite period, and an image consent is also signed according to the country's legislation.*

How? Assessment, Assignment

The credential awarding describes the protocols to integrate a credential and the metadata that allows recognizing the scope of what it grants and recognizes. The experts indicated the elements that are considered for the recognition of credentials. In the case of evaluations, automated ones were designed with self-assessments, peer evaluations, and others with review by a teacher, which was integrated into the cost of the business model.

> *PA: For example, several evaluation instruments were considered, some were automated using the platform functionalities, and others were evaluated by professors as they were part of the accreditation.*

On the other hand, the protocols were formalized based on institutional regulations for the credential assignment to the student. For example, it was specified to cover the credits or units required to be validated later. This involved formalizing an institutional statement on the definition and scope of credentials that could be comparable to the courses of an academic program.

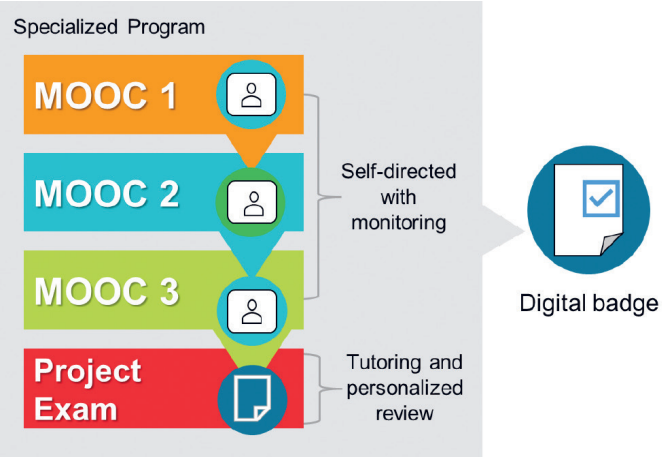
When? Accreditation throughout life

The credential accreditation must be clear for the student, educational institutions, and the labor market to recognize and facilitate the beneficiary's mobility. In this case, the student applying for the credential had to deliver activities (products) that were evaluated and served as evidence of developing their skills and abilities. There were several competency evaluation models, such as e-portfolios and summative evaluations, in addition to the development of projects (Figure 4). A specific level of qualification was established for the evaluation instruments from the course design based on the academic program's requirements.

> *PB: Accreditation goes beyond just completing the course; the student must demonstrate the competence acquired.*

Figure 4

Accreditation Scheme for the Specialized Education Program



Where? Recognition, Portability

Recognition and portability consider aspects of evaluation, flexibility, relevance, and standardization and provide transparency and certainty to students and other organizations about alternative credentials. The participants described these aspects based on the projects they carried out.

In this case, the implementation of alternative credentials fulfilled the purpose of the specialized program of the Department of Humanities and Education since it achieved international projection and visibility and attracted new students to the academic program. Participants explained that before the COVID-19 health contingency, adults in graduate and continuing education were interested in alternative credentials. Now, they found interest emerging from young adults as well.

> *PA: Before COVID-19 we might have claimed it worked best for "middle-aged and older adults" in graduate and continuing education, but now we are seeing "young adults" searching and inquiring for these courses.*

Students who meet the requirements receive a digital certificate with the name of the credential, which they can share on their social networks and include in their portfolios. The participants' experience in the graduate program indicated that the certification accreditation could be validated with a master's degree course in Education.

In summary, the elements and strategies of the case presented coincided with the two reference frameworks consulted in implementing alternative credentials. Furthermore, the reviewed case added a feature regarding the intellectual property of the content of the alternative credentials, which was not found in the reference frameworks (Table 6).

Table 6

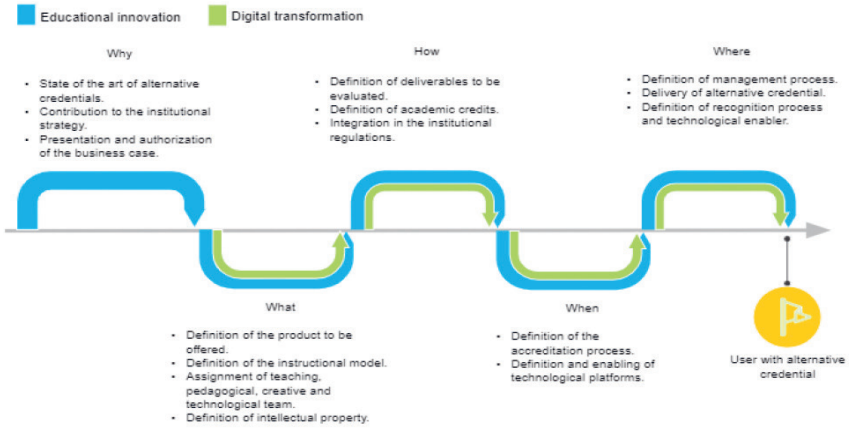
Elements considered in the implementation of digital credentials (own elaboration)

Microcredential Quality Markers for Postsecondary Institutions (Pichette *et al*., 2021)	The Micro-Credential (MCs) Users' Guide (Hudak & Camilleri, 2018)	Tecnológico de Monterrey
*Definition	Definitions & Classification	What: Definition Flexibility Intellectual property
Flexible		
Not included	Not included	
Relevant	Vision, Mission, and Strategy for MCs at the institutional level	Why: Institutional Strategy
Accredited	Accreditation & Quality Assurance	When: Accreditation
Standardized	Awarding Micro-Credentials	How: Assessment and Assignment Process
Assessed		
Stackable	Academic recognition & portability of micro-credentials	Where: Recognition and portability

*Note: Pichette *et al*. (2021) refer to the need to have a definition of micro-credentials, although they do not include it in the quality elements but treat it separately.

Based on the results, a trajectory was identified for the design of the alternative credentials, where the key elements considered for their management and implementation stood out (Figure 5). In this process, the questionnaire items on using alternative credentials (Appendix 1) were linked, which are of value to institutions and organizations interested in scaling these training possibilities upward with educational innovations.

Figure 5
Alternative credentials management



This management process can be a reference for institutions or organizations interested in alternative credentials, where educational innovation is a transversal axis and the engine of digital transformations. The implications for practice identify the need to analyze the context, the motivation to offer new training possibilities and the support of human resources and infrastructure that accompany this action. It is also of substantial importance to consider the implications of educational research as a critical element in generating knowledge about educational innovation.

Discussion

Although alternative credentials have been present in the last two decades, there is still no internationally approved concept. The reference frameworks used, and the case study presented here agree on more than 70% of the elements required in the implementation of an alternative credential strategy (Figure 3); they also raise the importance of having a common definition, and given the lack of international consensus, each interested party proposes its own (Table 2). The International Labor Organization uses “digital credential” and “micro-credential” interchangeably (International Labor Organization, 2021). However, Pichette *et al*. (2021) and Hudak & Camilleri (2018) refer to them as micro-credentials and Tecnologico de Monterrey (2019) as alternative credentials. This lack of consensus continues to be an opportunity for this educational trend; it is necessary to move from the state of novelty to seek practicality that provides transparency to the users and parties involved.

Educational institutions must define a strategy that includes their vision, mission, and operating framework for alternative credentials in their value offering. The reference frameworks are a guide for the institutions, but no details were found for their operation; however, in the case study, we emphasized and propose a framework that includes aspects of design, management, and even intellectual property (figure 5). For Canadians, institutions and governments must establish the target audience for credentials (Pichette *et al*., 2021). Technology facilitates portability, security features, and alternative credential programs’ storage, verification, and scalability (Brown *et al*., 2021; DCC, 2019). Once clear on the significance of alternative credentials for the institution, the next step is to establish the “how” of their implementation.

Alternative credentials must be explicitly detailed with user and credential information so that other organizations can recognize them. The awarding of credentials must align with the established evaluation model that is transparent to the student and easy to interpret by third parties so that they can incorporate them into their processes and programs. Aspects such as duration, evaluation process, stacking, and providers, among others, are helpful metadata for awarding credentials and disseminating student achievements (Cirlan & Loukkola, 2020; Erasmus+ Programme,

2019; Kato *et al*., 2020). The body responsible for granting the alternative credentials must be readily identifiable to strengthen and validate the process.

The alternative credential must add value to the labor market. Credential quality is considered in the reference frameworks and the case study as a critical element of the implementation process to ensure the useful life of the conferred credential. Since the alternative credentials granted by higher education institution s are part of their value offerings, they must be subject to the same quality assurance processes as their other programs (Hudak & Camilleri, 2018). Likewise, institutions must verify the applicable regulations of the corresponding educational authority for their accreditation (European Commission, 2020), making it possible for granted alternative credentials to be recognized by other organizations.

The flexibility and versatility offered by alternative credentials allow the users to take different paths in their professional development. This has led organizations to consider credential stackability as part of their undergraduate or graduate programs and use technologies to manage them. This integration into programs must be thought of in terms of the needs of the labor market instead of trying to adapt or partition the current curriculum (Pichette *et al*., 2021). Blockchain technology has become an enabler of the portability of alternative credentials, and educational institutions in various parts of the world have implemented it (International Labor Organization, 2021; Longino Torres, 2019). The adoption of technologies demands that institutions continuously update and make consequent adjustments to their processes to leverage the benefits they provide to users.

Limitations

A limitation of this study is its small scope because it only considers one program from a higher education institution. However, the analysis results can serve as a reference for other institutions to explore the implementation of alternative credentials in their offerings. Future studies may consider, on the one hand a longitudinal study of the results of the implementation of alternative credentials in the institution, and, on the other, the study can expand the sample of universities by compiling other experiences, either in the same country or at the regional level, documenting users' experience and satisfaction.

Conclusions

The purpose of this research was to present a case study of implementing alternative credentials in a higher education institution in Mexico to identify best practices that serve as a reference for those universities and organizations interested in venturing into this trend. Change has become a constant due to implementing new technologies, which have led to the digital transformation of organizations. The COVID-19 pandemic intensely challenged educational institutions (Aguaded & Contreras-Pulido, 2020; Ramírez-Montoya & Lugo-Ocando, 2020). Based on the results of this study, it was possible to verify the international interest in the use of alternative credentials in Europe, Australia and North America, national and regional experiences, among which it was found that there is a lack of a consensus on the definition and scope of these credentials.

Another conclusion that can guide communities interested in educational innovation and alternative credentials is that consensus was found on a series of elements, the approach and processes universities have considered in their management process of alternative credentials: why they are going to venture into this trend, the strategy to follow, the added value of their offering, the elements that define it and its design, how to conduct the evaluation and assignment process, when the accreditation is carried out, and where it is recognized. This article presents an alternative credential management process as a guide for higher education institutions, not without considering that there continue to be opportunities at a global level around its definition, interest in ensuring quality, as well as clarity for students and companies and organizations on the recognition and validity of the knowledge and skills acquired.

Finally, alliances between countries, organizations, and higher education institutions could allow the advancement of this educational innovation, which is now highly relevant for talent training (upskilling, reskilling, outskilling). With this, students, workers and companies can understand and have confidence in the knowledge and skills they certify and the quality of the supplier entities. This trend opens the opportunity for universities to diversify their offer, for students and workers to broaden their knowledge and skills, and for organizations and companies to diversify their recruitment processes and have access to more people with the required profile.

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The authors have no competing interests to declare.

Authors' contributions

Three authors contributed to the content of the article, conceptualizing the approach (Author 2, Author 3), supporting the study theoretically and methodologically (Author 1, Author 3), and discussing the data (Author 1, Author 2).

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Annex 1
Questionnaire on the use of alternative credentials

Why? Added value, institutional strategy

- What are the essential elements to consider when defining a micro-credential?
- What is the purpose of its use in undergraduate studies? Level content, update and/or complement current curricula with elective courses?
- Were they used to open non-existent offerings at the university in specific topics leading to a qualification or professional updating (graduates and/or external)?
- How do you define the contents?
- What is the flexibility model that you have defined for micro-credentials?
- Do you have the same courses on Coursera and edX? How do they define which course they offer on one platform or another if they are different?
- How is it organized? Are they separate units, or are they included in each degree/unit?
- How are the protocols formalized to generate a credential? Are there requirements to declare it, forms to fill out, and minimum course hours?
- How are teachers who participate in the production rewarded when it is made and when the micro-credential is executed? Are teachers paid for the construction of asynchronous material? If they are paid, do they do it for the hours of dedication or the resulting hours for the students?
- Is an hourly rate paid or a percentage of the revenue if the courses are sold?
- Do teachers get paid each time the program is taught even though there is no interaction?
- Do you have a calculation of hours worked per teacher for each “asynchronous teaching” hour?
- How are tutors who support implementation rewarded?
- What are the costs involved in creating a micro-credential? What are the most critical points to keep in mind?
- What is the operational and cost structure to produce micro-credentials?
- Do you charge undergraduate students? Are they offered to collaborators and teachers under special conditions?
- What business models have you explored? Which ones are the most effective?

What? Definition, design

- What are the defined segments? Are they subjects whose structure better allows delivering specific content or developing skills/competencies? Can they be practical subjects, or is it fundamentally oriented toward theoretical classes? Are they rather instrumental, or can they be exploratory?
- When defining a micro-credential, do you have a defined process to formalize the course?
- When is a development considered to be new compared to an earlier one?
- How do you transition when using parts of another micro-credential? Is it done by modules or by credentials?
- How short can a course/program be under the Tec model so that a micro-credential can be awarded?
- What are the formats used? Are micro-credentials only offered online?
- What methodologies and/or tools are used for the design?
- What are the forms that deliver the content? (videos, readings, external materials).
- Is your design different from a regular degree course? Do you have particular specifications in your planning and/or implementation? (Duration, academic hours, learning objectives, methodologies, evaluation, etc.)

- Are the assessments all self-correcting? Do you have evaluations that require someone to review, correct, and apply criteria?
- How do you calculate asynchronous student work hours?
- What is the role of teachers in implementation? Do they answer questions? Do you proofread jobs?
- Is there an academic tutor and a service tutor?
- How much time is required to develop a micro-credential course and offer it?
- What types of tools are used to ensure levels of learning?
- What factors do you consider in quality control?
- Who and how is the course designed and produced? Is there a department in charge of this?
- Who owns the Intellectual Property? How is it managed?
- Do they have different treatments for external teachers versus contracted ones?
- What protection do you take if a teacher leaves the institution? Do you sign any transfer of rights? Indefinite or for a fixed term?

How? The evaluation process, assignment

- How are content evaluations carried out? (Partial evaluations, final evaluation, types of assessment).
- How are competencies assessed in asynchronous courses? What kind of instruments are used?
- How do you ensure standardization in students' experience taking a micro-credential course?

When? Accreditation, throughout life

- How do you see the option of delivering the certification without taking the course, that is, accrediting the competency or knowledge?
- Do they have experience integrating a micro-credential course into the undergraduate or graduate curriculum? If so, could an evaluation be defined that certifies the competence and/or ability?
- If the student does not pass, will they be able to take the course in micro-credential format and then obtain certification if they meet the defined evaluation?

Where? Recognition and portability

- What has been Tec's experience with micro-credentials offered through interdisciplinary courses/ programs? What possible benefits can be seen in applying this model to this type of program vs. disciplinary programs?
- What things work best? Which market is more receptive?
- How does dissemination occur? Internally, through the platform used (edX, Coursera), or mixed?
- Have you explored third-party certification for your students?
- How is the certification curriculum sheet reflected? Diploma? LinkedIn?
- What are the characteristics of the components of a learning path and its criteria?
- Where can we see all the micro-credentials offered to the different segments?

ANEXO IV

Artículo. Digital Transformation in Higher Education: Qualitative Evaluation

Number of words: 4,577
Number of figures: 4
Number of tables: 3

Digital Transformation in Higher Education: Qualitative Evaluation
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Abstract
Digital transformation goes beyond the implementation of technology in institutions; its adoption impacts their strategy and organization, processes, products and services and, as a consequence, they require talent to meet the new demands of the work environment. The aim of this research was to analyze the elements of digital transformation in higher education through an experience in digital education. The research was carried out with the qualitative evaluative method, applying interviews to multidisciplinary staff of a Latin American university, with four categories of analysis: strategy, people, technology, and processes. The results showed that (a) it is important to have an institutional strategy that guides and enables the implementation of digital education in the university to promote its adoption; (b) the updating and retraining of talent is essential to carry out the digital transformation in the organization; (c) the digital transformation of roles, products, and services requires continuous investment in technology infrastructure, and (d) requires a rethinking of processes to take advantage of and scale new technologies. This study may be of value to administrators, teachers, and decision-makers interested in carrying out digital transformation actions in educational institutions.

Keywords
Educational innovation1, higher education2, digital literacy3, digital transformation4, digital education5.

KEY POINTS

What is already known about this topic:

(1) By incorporating technologies into various aspects of their work and value processes, higher education institutions incur in their digital transformation.

(2) Digital education helps to meet flexibility needs for teachers and students, as well as to provide new learning experiences in line with the demands of the work environment.

What this topic adds:

(1) Digital education, and the digital transformation it involves must be part of an institutional strategy and be governed by the value they will have on student learning.

(2) The deployment of digital education in higher education institutions should be adopted from a systemic and planned approach, identifying the impacted processes, as well as the new ones that are intended to be developed.

(3) The personnel involved (teachers, students, collaborators) must have a clear understanding of the focus and scope of digital education and the digital transformation that is required, as well as training opportunities to develop the necessary skills to make the best use of them.

(4) Instrument to guide the digital transformation of higher education institutions.

1 Introduction

Society has undergone a continuous transformation since new technologies were incorporated into the means of production and their subsequent adoption in other areas of life. As a consequence, higher education institutions (HEIs) constantly face new demands to provide relevant training, considering that these changes require the continuous updating of pedagogical approaches, their members and their internal processes (Alhubaishy and Aljuhani, 2021; Byrnes *et al*., 2020). Therefore, it is necessary to review and validate digital technologies to integrate them into the value process of HEIs, ensuring academic quality and the experience of faculty and students.

The adoption of Information and Communication Technologies (ICT) in HEIs has revealed new alternatives for the design and implementation of the teaching-learning process. A study on the impact of COVID-19 on Higher Education worldwide found that one-third of HEIs had online programs prior to the COVID-19 health contingency; however, the lessons learned from this stage have led to the deployment of new digital modalities (mixed and hybrid, synchronous and asynchronous) that offer greater flexibility to the academic offer (George-Reyes *et al.*, 2023b; Marinoni *et al.*, 2020). Consequently, the exploration and validation of pedagogical methodologies and strategies that underpin digital modalities becomes decisive to guarantee the quality of the training provided by HEIs (Aguaded *et al.*, 2023; Beltrán Hernández De Galindo and Ramírez-Montoya, 2019). To carry out this transformation, it is necessary to identify and define the elements that contribute to universities in their proper implementation.

Digital transformation is a process that must be planned, as it has an impact on all aspects of the organization. The adoption of technology required educational institutions to migrate content in format analogous to the digital format (*digitization*) to take advantage of digital technologies such as content platforms (*Learning Management Systems*), social networks, electronic means of communication, among others (digitalization) (Alenezi, 2021; Niță and Guțu, 2023). In addition to resources and content, higher education institutions also transformed processes and services, developing digital competencies of students, teachers, and collaborators to ensure academic continuity during the COVID-19 health pandemic (Gaete Quezada, 2023; George-Reyes *et al.*, 2023a; Wong-Galvez and Libaque-Saenz, 2023) (Figure 1). The implementation of digital transformation requires a systemic approach focused on enabling the learning process and experience of the student body.

Fig. 1. Digital Transformation in Higher Education Institutions (own elaboration)

The Global Education Monitoring Report 2023 points out that higher education is the education level that is implementing digital technology the fastest, however, developing and sustaining this transformation could increase the funding gap of low- and lower-middle-income countries by 50% (UNESCO, 2023); an example of this is Mexico, in which it was found that in 2023 the main challenges for ICT integration are the lack of classrooms and infrastructure, as well as the lack of digital skills of teachers (Castañeda De León *et al.*, 2023). This is of particular interest, as technological progress becomes more specialized, for example, the use of artificial intelligence, and both countries and institutions must find a sustainable strategy to stay relevant and in tune with the needs of the work environment.

This digital transformation is present in the value and enabling processes of HEIs, and has an impact on their members, so it must be part of the institutions' strategy. The learning process should incorporate new methodologies and

various technologies for students and teachers (Bygstad *et al.*, 2022; Díaz-Garcia *et al.*, 2023); an example of this is the emergence of blended learning modalities that include a combination of online and offline learning options in higher education (Shenkoya and Kim, 2023). Likewise, with the emergence of artificial intelligence applications, the scope of transformation of university processes is expanded, such as automation of enrollment applications review, allocation of schedules, personalized recommendations for professional guidance, campus security monitoring, among others (George and Wooden, 2023; Kabashkin *et al.*, 2023). All of this has an impact on administrators, students, and faculty (Tri and Hoang, 2023), which brings new roles for students and faculty, and even allows for the implementation of new means to incorporate companies and organizations into campus life (Bygstad *et al.*, 2022). It is no longer a question of whether or not to carry out the digital transformation of HEIs, but of having the plans and equipment for its deployment and use.

Higher education institutions as primary training venues for working life must remain relevant to ensure that graduates are prepared and able to adapt to a changing world. A reflection of the adoption of these changes in education, in the last two decades, has been the integration of various elements such as new pedagogical strategies, new modalities of training delivery, incorporation of information and communication technologies, as well as educational innovation to transform the learning experience (Alenezi, 2021; Romero-Rodríguez *et al.*, 2023; Veletsianos *et al.*, 2021), which has been called digital education (Yang *et al.*, 2022). In addition to this term, other concepts have emerged that take characteristics from technology for use in education.

The terms of the educational offer used should be clear enough for students to select the one that provides the appropriate experience for their needs. However, in practice, the terms are used interchangeably according to the characteristics to be highlighted such as e-learning (Basu *et al.*, 2022; Visintini, 2022), and online or distance education (Sangrà *et al.*, 2023). Others define digital education based on the modality of learning whether face-to-face, *blended* or completely online, in which digital technology can be incorporated to varying degrees (Observatorio IFE, 2024; Veletsianos *et al.*, 2021); and learning modality is understood as how a student accesses and participates in a learning experience (Johnson, 2023). A study conducted in the United States on learning modalities by Johnson *et al* (2022) resulted in a broader version of definitions to accommodate different variants of technology use (Figure 2).

Fig. 2. Modes of Learning Spectrum (Johnson *et al.*, 2022)

In this way, Figure 1 groups the modalities in distance education and face-to-face education with variants each; even so, the range of technologies and teaching methods that continue to emerge create a variety of learning experiences and there can be a temptation to further disaggregate the modalities, which can be counterproductive to their management and understanding by users (Johnson, 2023). The modality that makes the most intensive use of technology is distance and online education.

The adoption of technologies in teaching must be focused on enriching the student's learning experience and the institution must have a strategy and the necessary enablers for its implementation. Among the digital characteristics that have driven online teaching, Hilbert (2020) points out five and agrees with other authors (Basu *et al.*, 2022; Shenkoya and Kim, 2023): 1) economies of scale, since content can be reused countless times; 2) the death of distance, because technology brings together physically separated teachers and students; 3) timeless time, through asynchronous content delivery, which enables the personalization of learning in when, how, and where learning occurs; 4) multidirectional networks of interaction and communication one to one, one to many, many to one and many to many, since "learning to receive reactions and comments from others is an important part of the educational process" (Hilbert, 2020, p. 23) and, 5) the digital footprint of the students, recorded through learning analytics, which allow the teacher to know their performance and plan intervention activities. In addition to these characteristics, it is necessary to bear in mind that the partnership with technology providers involves a continuous analysis of the environment and negotiation of contracts to maintain a sustainable relationship and service.

What considerations should HEIs consider when implementing digital education to ensure academic quality? Derived from the experience of the Covid-19 health contingency, instruments were developed to analyze the experience of students (Garcia-Castelan *et al.*, 2021) and teachers in the online modality, as well as the preparation of

HEIs to respond to the sudden digital transformation they faced in this period (Väljataga *et al.*, 2021). In addition, frameworks and models on digital transformation were found, which focus on aspects such as the application of systems, data and technological infrastructure (Alenezi and Akour, 2023), implementation of advanced technology such as artificial intelligence and its impact on the current profiles and roles of HEIs (Kabashkin *et al.*, 2023), as well as business opportunities and development of new strategies (Rof *et al.*, 2020) and financial resources necessary for their implementation and deployment (Wong-Galvez and Libaque-Saenz, 2023). García-Peñalvo (2021) presents a framework for eLearning that coincides with some of the above aspects and adds others such as the educational model and digital content. Based on the above, this research seeks to identify the elements of the digital transformation of a Latin American university through its experience in digital education in a way that serves as a guide for HEIs interested in venturing into digital education and digital transformation, since it is required to have a strategy to have clarity in the scope and count the necessary resources, appropriate processes and technologies, as well as ensuring that teachers, students and collaborators have the required competencies.

2 Materials and method

In this research, the qualitative evaluative method was applied, using interviews to collect answers to the questions of the research instrument. In the qualitative method, the researcher has direct contact with the participants, either through interviews or focus groups (Creswell, 2014). The participation of the researcher is essential in the collection of information, as he or she can adapt the pace and contents of the interview to cover the objective of the research (Merriam, 2002). The dynamics of interaction between the researcher and the participants must be prepared in advance to promote an environment of trust, professionalism, as well as to clarify expectations.

Participants

The group of participants was made up of members of a multidisciplinary team in charge of the design of digital education courses at a Latin American university, and among their functions they provide pedagogical and technological advice in the design of courses, development of digital educational resources, as well as quality assurance and continuous improvement to incorporate new educational strategies and trends. The following table lists the six participants and their roles, four women and 2 men (Table 1):

Table 1. Participants' role

Instruments

For this research, interviews were used as a data collection instrument. Qualitative interviews can be structured or unstructured, or a combination of both, semi-structured, and are useful for inquiring about participants' experiences, as well as guiding the session to topics of interest (Creswell *et al.*, 2004; Merriam, 2002). For this research, the instrument used aims to identify how a higher education institution carries out the implementation of digital education programs and how they are framed in its digital transformation. The handling of the information was carried out to ensure the confidentiality of the opinions expressed, as well as the anonymity of the participants (Traxler, 2012). People voluntarily participated in the study.

The design of the instrument was integrated with open-ended questions to collect participants' experience in the research topic. The questions were grouped into four sections: a) strategy (institutional guidelines that apply to the entire organization), b) processes (operations that enable valuable services), c) technology (infrastructure to enable digital education), and d) people (stakeholders and requirements to carry out digital education). The total number of questions in the survey was 51 and before starting the interviews, the methodology of its implementation and the agenda of the sessions were agreed with the participants; the interviews were conducted online, through the Zoom platform in two sessions of 1.5 hours each.

Prior to the implementation of the instrument, it is necessary to ensure its clarity and relevance. In this research, the instrument was validated by a team of experts in the field, who provided valuable contributions for its improvement (Andres, 2015; Escobar-Pérez and Cuervo-Martínez, 2008). The group of three experts each has more than 20

years of experience in the implementation of digital education. The experts evaluated the instrument considering clarity, coherence and relevance and provided feedback on the wording of the questions and their relationship to the topics to be explored.

Categories and data analysis
The data analysis was carried out with the classification of the interview responses, using as a reference the framework for eLearning in higher education institutions by García-Peñalvo (2021) and the Guide for the Comprehensive Implementation of Digital Education in Universities by Tecnológico de Monterrey (Observatorio IFE, 2024) (Table 2). These references were selected because they are focused on digital education in higher education institutions and are the focus of this research. In addition, based on the responses obtained, new categories were identified to group and encompass the shared experiences.

Table 2. Categories of analysis
The two proposals coincide in more than half of the criteria, for example, having an institutional strategy and guidelines for implementation, as well as processes to provide the required services, the adaptation of the educational model to the digital modality, infrastructure required for the enablement of the digital modality, and, in turn, each one provides other criteria such as issues of ethics and data privacy and communication, and financing (Table 3).

Table 3. Relationship of digital education models with digital transformation categories

3 Results
The interview responses were grouped into four categories a) strategy, b) processes, c) technology, and d) people, considering the systemic approach to digital transformation in higher education institutions (Figure 1), and for each category subcategories were indicated to give more context on each (Figure 3). This categorization helps to identify common elements with other models, as well as aspects that denote importance to the interviewed production team.

Fig. 3. Categorization of Interview Responses

The distribution of responses was higher in the topic of processes (45%), since it represents the specialty of the participants; next was the topic of strategy (30%), which they must consider in order to comply with the institution's guidelines, and the category of people and technology obtained the same number of responses (12%) (Figure 4). Digital educational resources require design and management processes appropriate to the technologies used.

Fig. 4. Distribution of responses by category

Strategy
Responses on the strategy category were answered by participants with administrative roles; these participants indicated that decisions about the guidelines that apply to academic programs, and this includes those of digital education, governance, are made in the top management of the university. Among the guidelines are those related to the work of teachers such as the creditable hours of the courses, the payment for the design, as well as the time that will be allocated to the design of the digital education courses, in addition to the scaling of the programs:

Q1: The estimated time that the teacher dedicates to the design of the courses is four months since he/she combines it with his/her workload.

P2. Decisions to scale programs and infrastructure are made by senior management. The offer has remained fixed, but it is expected to increase due to the experience during the Covid-19 health contingency.

As for the courses that make up the digital education offer, this is defined jointly between two areas, the faculty to which the course belongs and the central area responsible for the design of digital resources and pedagogical advice.

Q1: The course offer is defined in conjunction with the department to which the course belongs.

P1. The selection of the courses that will be taught is made through a call for proposal twice a year aimed at university professors.

Regarding the organizational structure of the area, this is a central area, that is, it serves the entire university, in this way with a centrally defined offer it can be planned the required resources and its production capacity:

Q1: The unit [responsible for the production of digital education courses] is made up of three areas: design, multimedia, and production. It has six members.

P1. The course production team in the central design area works with the teachers who applied and are selected.

Process

Another category referred to the processes used for the design of the digital education offer, which involve aspects of pedagogical design, assessment, and production and management of educational resources. Pedagogical design is one of the valuable activities provided by the area, as it guides the teacher to adapt the content from a face-to-face modality to the digital one.

P3. The instructional design model used was created at the university and includes various pedagogical strategies to promote learning.

P2. The [production] flow follows five steps to design the courses: design, content development, implementation, and evaluation.

Regarding the issue of assessment, they have instruments with diverse scope ranging from the evaluation of the student's knowledge, the student's perception of the course design and the teacher's performance, which they apply during the process they follow in digital education:

P3. The guidelines we have for the design of the courses include rubric assessment instruments, peer assessment.

P2. We have two instruments to evaluate the design of the courses: a special one that is applied at the end of the school term to evaluate the student's perception, and another that is the institutional one to evaluate the teaching performance.

The production of educational resources is part of the expertise of the members of the production team, so they dedicate time to advising the teacher to select the formats that best present the contents, and they keep an agenda for the development of the resources of the offer by period to meet the stipulated times.

P6. During the video production we work with the teacher, the instructional designer and the audiovisual producer. We have design guidelines in place to ensure the quality and delivery of videos on a commercial platform.

P4. The process of recording the videos of the courses we follow is first to develop a script based on an established protocol, we carry out tests and then we proceed to the recording on location at the university or outside of it.

P5. The resources we have in a standardized production are infographics and animations for which we use predefined templates.

P2. We follow up on the design of the courses through a scheduling template. We establish weekly activities including face-to-face and virtual sessions with the teacher. An instructional designer, a multimedia designer and an audiovisual producer are assigned per course according to the resources to be developed.

For the management of the resources, they use the computer equipment of the members of the group, since they do not have a central repository, which makes it difficult to reuse the resources between the courses.

P5. We save the [multimedia resources] on the computer and back them up to a Drive in the university's cloud, although there is no established protocol to store the information.

P6. The videos are collected on the computer and on a hard drive and a way to have a backup in the cloud is sought.

P1. The resources are not licensed by the university, nor are they openly licensed; we only include the logo of the university, and the faculty sign a property policy [copyright] of the university.

Technology

Technology is a fundamental enabler for the design and delivery of digital education, since it is through technology that teachers and students meet in a virtual classroom and find the content and activities to be carried out.

P2. The infrastructure is an LMS Canvas platform, a Vimeo platform license for video publishing, a video recording room, licenses for graphic design and video production software, and an image database.

P6. The technological resources we use for the development of audiovisual products and services are a studio, 2 Sony cameras, a teleprompter, and we take advantage of natural light.

P6. The recording studio has a chroma key, 2 TNL lighting equipment, 2 Sony cameras, 2 wireless microphones, 1 MacBook pro to record tutorials, 1 speaker, 1 interactive whiteboard and 2 TV screens.

People

The people category includes the roles involved in the design of digital education courses. Among the topics that stand out are roles, training, and evaluation of these roles. Role management is carried out by the coordinator responsible for the role.

P2. The production job profiles are audiovisual producer, who handles audio and video recording and editing; multimedia designer who manages graphic editing programs, animations, and interactive infographics.

Regarding the issue of training, the strategy used by both the production team and the university professors was investigated, and it was found that there is a latent interest in the production team to have a continuous training program, given that technology is constantly evolving. And in the case of teachers, the training offered is for those selected to develop digital education courses.

P3. The training of instructional designers is based on the university's educational model. Although we believe that it would be convenient to have more training in technological aspects and educational innovation.

P2. There is no formal training program for digital education processes [for teachers], only tutorials and resources are offered on the use and best practices of digital tools and platforms.

The last category refers to the evaluation of the performance of the roles involved in the design of digital edu-

cation courses. In this case, an opportunity was identified since only the evaluation of the teacher's performance is carried out, which is carried out through a survey of students at the end of the school year.

P2. We have an institutional teacher evaluation survey that is applied at the end of the course to all face-to-face and digital education groups. In addition, the digital education team applies a perception survey to students at the end of the course.

P3. We don't have a process for feedback on the instructional designer's work.

*The opportunity l*ies in the fact that there are others involved who can benefit from feedback for continuous improvement.

4 Discussion

The deployment of digital education in HEIs must be adopted from a systemic and planned approach. Digital transformation goes beyond technology, it is necessary to have a strategy, identify and adapt the impacted processes, in addition to ensuring that teachers and students have the required competencies to take advantage of them (Figure 3). Digital education requires technology so that, in remote moments, self-learning and collaboration are carried out in a way that makes learning transparent for students and teachers (Basu *et al.*, 2022; Hilbert, 2020; Shenkoya and Kim, 2023). HEIs must be clear about the scope and intent of incorporating digital education into their academic offerings.

The strategy must provide direction, meaning and answers about the why, purpose, of the initiatives and how they are implemented. In this research, it was found that the conceptual and deployment guidelines, as well as the offer, were dictated from the top management to the entire institution (Figure 4). In the case of the offer, for example, it is necessary to define its scope within the spectrum of digital education, online or *blended*, since this has an impact on the processes, technologies, didactic strategies, and training programs to be implemented (Johnson, 2023; Johnson *et al.*, 2022). It is necessary to be clear about the value that digital education will bring to student learning to plan its deployment.

By having the digital education strategy in place, the processes and those responsible for the processes to implement the transformation and integration of digital elements are immediately identified. The processes identified in the study were related to pedagogical design, the production and management of resources, as well as the evaluation of satisfaction, and these were the responsibility of the central unit in charge of designing the digital offer (Table 3). In addition to these processes, it is also necessary to consider the adaptation of academic services, the design of content adapted to the selected modality, professional guidance, among others (García-Peñalvo, 2021; George and Wooden, 2023; Kabashkin *et al.*, 2023; Observatorio IFE, 2024). Once it has been defined what is to be done and how, the enabling technologies are selected.

There is a latent temptation to put technology first over educational strategy. However, having clarity in the didactic strategies to be implemented, it is possible to identify, evaluate and select the most appropriate technology such as technological platforms (LMS) and equip spaces with infrastructure for the design of digital educational resources. Educational technology and technological and service infrastructure must contribute to transforming the learning experience (Alenezi, 2021; Romero-Rodríguez *et al.*, 2023; Veletsianos *et al.*, 2021). And a next phase requires involving teachers, students, and collaborators to implement the selected processes and technologies.

Changes in processes and technologies require users to learn and unlearn knowledge and skills to remain relevant and be prepared for changes in the environment. It is necessary to have the required roles, as well as up-to-date and suitable training programs, as well as means of evaluation to ensure quality (Table 3). Although the implementation of technologies opens up new opportunities in the deployment of education, it also represents challenges such as having the economic resources for its maintenance (UNESCO, 2023), as well as developing new roles and competencies for teachers and students (Castañeda De León *et al.*, 2023; Tri and Hoang, 2023). Training for digital transformation is key to the paths of change proposed in institutions.

Conclusions

The objective of this research was to identify how a Latin American higher education institution carries out the implementation of digital education and how they are framed in the digital transformation. The actions carried out by the institution of the study are in accordance with guidelines and recommendations raised by other experiences in Latin America and Spain, which denotes that having an institutional strategy that includes the guidelines of governance, academic offer and responsible structures provides clarity and focus for the deployment of the necessary processes, whether it is adaptation of the current ones and/or generation of new ones. Equally important is the identification, evaluation, and selection of technology to enable processes and experiences, which must be aligned with the pedagogical strategy and not the other way around. Thus, by having an institutional strategy, the processes identified and enabled, and the technology selected, a clear message can be provided with a deployment route so that users, teachers, students, and collaborators adopt digital education and have the necessary skills to make the best use of it.

Another aspect to consider in the implementation of digital education in HEIs is to analyze the circumstances of the environment to make adjustments in strategy, processes and technologies due to the fact that new technologies are continuously emerging and HEIs may fall into the temptation to focus on testing for novelty, leaving aside the pedagogical aspect; The government, from the strategy, must point out the path to follow to achieve a balance by seeking innovation to enrich learning, as well as the economic and infrastructural resources to achieve it.

Implications for practice and research

Although digital education had a greater impact with the internet, there is still diversity about this concept, and depending on the focus or what is highlighted, new terms arise, which causes confusion and makes it difficult to communicate with students in their selection of courses or programs according to the needs they want to cover, as well as companies when they need to validate the added value provided by digital education. It is necessary for HEIs to carry out inter-institutional and transversal agreements to facilitate understanding by users. Likewise, advancing on the topic of digital transformation brings implications for research to study the phenomenon from various perspectives and actors, trying to generate knowledge for educational innovation.

Limitations and future studies

The sample size of this research was limited to one higher education institution, so for future research larger samples could be considered and carried out in other HEIs and countries. Likewise, the instrument used can be further improved and expanded considering the characteristics of the concepts of digital education and digital transformation in this study, to remain relevant over time.

5 Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

6 Author Contributions

Three authors contributed to the content of the article, conceptualizing the approach (Aguaded, Ramírez-Montoya), supporting the study theoretically and methodologically (Farias-Gaytán, Ramírez-Montoya), and discussing the data (Farias-Gaytán, Aguaded).

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Instrument
Diagnostic instrument for the digital transformation of higher education involved in the design of digital education courses

a) Strategy
Organizational Structure

- Where is the area located organizationally within the institution?
- How is the area organized?
- How many people are in the area?
- Which departments are involved in the production of courses?
- What is the form of organization for the production of courses?

Government

- What indicators are used for decision-making?
- How are creditable hours allocated for courses?
- How are teaching hours assigned for courses?
- What is the process of hiring and paying for course designs for instructors?
- How are decisions made to scale programs and infrastructure?
- How do you establish the link with the penta-helix sectors (government, society, business, academia, and the environment)?

Offer

- How are courses chosen from the digital education offer?
- What considerations are considered for its definition?
- Who decides the academic offer?
- At what times during the year is the offer tendered?
- What is the estimated projection of the offer in the next five years?

b) Processes
Pedagogical design

- What are the processes focused on digital education?
- What instructional design models are used?
- What strategies are used in course design?
- What kind of educational resources are implemented?
- What flow (process) is followed to design the courses?
- What formats are available for the design of the courses?
- Evaluation
- What guidelines do you have for the design of the courses?
- What instruments are available to evaluate course design?
- How do you evaluate the impact of digital education courses?
- How is the implementation of the courses evaluated?
- How do you evaluate the impact of the courses?

Educational Resource Management

- What is the video production process like and how is it managed?
- What are the main challenges faced in video production and management?
- How is the reuse of generated resources promoted?
- Are the resources openly licensed?
- Production of educational resources
- How is the production of educational resources done?
- What are the stages of the production process?
- What resources do you have in mass production?
- What is the current situation of video production?
- What is the process of recording course videos?
- What processes are in place for self-recording videos for teachers?
- How are projects prioritized and allocated?
- How are the courses managed and monitored?

c) Technology
Infrastructure

- What is the infrastructure available for distance education?
- What technological resources are available for the development of products and services?
- How is the storage (technical, space and equipment requirements, bandwidth) of resources managed?
- What is the infrastructure in place for the delivery of the videos?
- How is the synchronous transmission space installed? (Technical, space and equipment requirements, bandwidth)
- What technological tools are used for production?

(d) People
Training

- How are instructional designers trained to work with course designs?
- How are teachers trained for remote processes?

Evaluation

- How is the work of the instructional designer evaluated or fed back?
- How are teachers evaluated?

Roles

- What roles are involved in project management in the area?
- What are the job profiles in the production area?

Table 1. Participants' role

Participant ID	Role
P1	Digital learning director
P2	Digital learning coordinator
P3	Digital learning coordinator
P4	Digital learning specialist
P5	Digital learning specialist
P6	Digital learning specialist

Table 2. Categories of analysis

An institutional reference framework for eLearning in higher education (García-Peñalvo, 2021)	Digital Education in Universities: A Comprehensive Implementation Guide (Observatorio IFE, 2024)
• Policy and strategy • Identity and communication • Ethics, privacy and security issues • Adaptation of the academic services • Educational model • Contents • Infrastructure	10. Why or purpose 11. Processes to define the digital offer 12. Incorporating digital learning into the university's educational model 13. Follow-up to implementation and quality assurance 14. Regulations and external accreditations 15. Technology & Service Infrastructure 16. Financing 17. Educational technologies 18. Organizational Culture

Table 3. Relationship of digital education models with digital transformation categories

Digital Transformation (Fig. 1)	An institutional reference framework for eLearning in higher education (García-Peñalvo, 2021)	Digital Education in Universities: A Comprehensive Implementation Guide (Observatorio IFE, 2024)	Digital Transformation (Fig. 1)
Strategy	• Policy and strategy	1. Why or purpose	Strategy
People	• Identity and communication	2. Processes to define the digital offer	Process
Strategy	• Ethics, privacy and security issues	3. Incorporating digital learning into the university's educational model	Strategy
Process	• Adaptation of the academic services	4. Follow-up to implementation and quality assurance	Process
Strategy	• Educational model	5. Regulations and external accreditations	Strategy
Process	• Contents	6. Technology & Service Infrastructure	Technology
Technology	• Infrastructure	7. Financing	Strategy
		8. Educational technologies	Technology
		9. Organizational Culture	People

ANEXO V

Proceedings. DIG-HE Digital Transformation Model in Higher Education: An Implementation Model

DIG-HE Digital Transformation Model in Higher Education: An Implementation Model
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Abstract
Digital transformation has become a constant state for organizations, including higher education institutions. This research aims to answer the question: What are the components of a digital transformation model that guides decision-making in Higher Education to select the best path to remain relevant to society's needs? The method for defining the model was research-based design with three phases: 1) context analysis (SLR and mapping), 2) analysis of digital transformation experiences in higher education, and 3) a proposal of a digital transformation model for higher education. The findings are: (a) a philosophical component which are quality, equitable, and solidarity-based education, inclusive digital worldview, culture of innovation and continuous improvement, and collective construction of digital knowledge; (b) a theoretical component supported by the theories of complexity, management of educational change, educational innovation, and experiential learning; (c) a policy component that refers to digital participatory governance, digital ethics and privacy, open access and equity policies, and cooperation and strategic alliances to guide the processes in the educational context, and (d) an operational component that interrelates strategy, process, technology, people, implementation, and evaluation with its inputs and outputs. The DIG-HE model is intended to be of value to academic communities and management interested in digital transformation initiatives.

Keywords
Digital Transformation, Educational Innovation, Higher Education.

Introduction
The current challenge of education is to be prepared to enable students to have the necessary skills to enter the workforce. Hence, technology becomes an enabling ally to address these challenges, and at the same time, it requires that users be prepared for its optimal use (Díaz-

García *et al*., 2023; Herrero and Spence, 2023); however, the digital transformation (DT) of Higher Education (HE) does not only occur in the classroom, but also in processes, strategies, and the implementation of technological infrastructure throughout the institution (Fernández *et al*., 2023; Tri and Hoang, 2023). Consequently, it is necessary to outline and plan for DT and its impacts.

[2]Technology has come to stay in the classroom and in the operation of HE, now it is necessary to establish a foundation and make appropriate decisions for its implementation. Studies related to the DT of HE identify aspects such as processes, technology implementation, financial resources, and their impact on users, whether students, faculty, or staff (Taher, 2023). Furthermore, other studies emphasise the importance of having an institutional strategy that includes DT (Fernández *et al*., 2023; Gaete, 2023), however, in the previously reviewed DT models, this is not included. Based on the above, this research aims to answer the question: What are the components of a DT model that guides decision-making in HE to select the best path to remain relevant to society's needs? The paper is organized in the following sections. A theoretical framework on the situation of DT in HE institutions and framework design, followed by the methodology, results and the framework proposal, then the discussion and conclusions.

Digital transformation of Higher Education

The process of education can no longer be conceived without the incorporation of didactic strategies and resources that utilise technological tools to provide experiences reflective of the work environment that students will face. Technology brings opportunities for education (Aguaded *et al*., 2022), it serves as a constant renewal impulse to stay relevant. Although there is no single definition of DT for HE, studies agree on terms such as the use of digital tools (Gkrimpizi *et al*., 2024), and to more specific processes like research, teaching and learning (Rahmadi, 2024). A systemic and planned approach will serve to align and achieve the desired outcomes.

The implementation of DT in HE faces dilemmas between addressing urgent needs, incorporating environmental trends, or following a planned evaluation process to select the most suitable path. DT is not limited solely to incorporating technologies in HE, but rather requires a strategy to identify those that add value, for example, in pedagogical strategies and teaching methods (Corbeil and Corbeil, 2022; Hashim *et al*., 2022), furthermore, that social and technological aspects integrate and complement each other (Bygstad *et al*., 2022). From the above, it is outlined the need to have a consensus-based and institutionally aligned process.

Digital transformation experience in Higher Education

The resolution of complex problems requires the consideration of all parts, their interconnections, needs, and interventions. In the development of a model, one must consider both the present and the future, that is, the desired impact for the future (Ramírez-Montoya, 2015). Therefore Ramírez-Montoya *et al*. (2024) propose the following elements in a model: 1) philosophy (ultimate goals), 2) theory (internal organisation), 3) policy (practical orientation), and 4) operation (processes). For the approach to complex problems, it is necessary to have a variety of alternatives to choose the most suitable and relevant one

Higher education institutions have approached DT from different perspectives. Some studies on DT models focus on measuring the institution's maturity to determine its readiness and among their findings, it is important to have clear leadership and a holistic vision of DT (Giang et a., 2021; Marks *et al*., 2020; Rodríguez-Abitia & Bribiesca-Correa, 2021). Another aspect HE faces is the lack of established processes or having them fragmented for the adoption of new technologies (Alzahrani *et al*., 2021; Mohamed *et al*., 2022). One aspect that stands out in studies is that of people, the users to whom it is necessary to provide training and communication to ensure their best experience (Giang et a., 2021; Marks *et al*., 2020; Rof *et al*., 2020; Rodríguez-Abitia & Bribiesca-Correa, 2021; Taher, 2023); consequently, the use of technology must be aligned with the institutional strategy and the needs of the users (Alfaro-Ponce *et al*., 2023). This research presents a framework for decision-making that takes into account strategy, processes, technology, and people.

[2] Esta comunicación ha sido remitida a comité evaluador de la12th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM2024). University of Alicante. Spain.

Method

The method for defining the DIG-HE Digital Transformation Model in Higher Education was design-based research. Wang and Hannafin (2005, p. 2) refer to it as '"a research methodology aimed to improve educational practices through systematic, flexible, and iterative review, analysis, design, development, and implementation, based upon collaboration among researchers and practitioners in real-world settings, and leading to design principles or theories". This method is useful for exploring innovations which helps to understand the relationships between theory, design, and practice and improve their design (Kennedy-Clark, 2013; The Design-Based Research Collective, 2003). For this study, systematic literature reviews were conducted, data collection instruments were designed, and implemented in HE since the objective of using this method was to develop a model that serves as a guide for decision-making in DT in HE, associated with theoretical and practical research.

The combination of theoretical aspects with practical experiences helps researchers to represent the state of the subject of study. Wang and Hannafin (2005) indicate five characteristics to consider when using this method, a pragmatic research goal, theory driven, and interactive, iterative, and flexible research process. In this study, these activities were integrated into three phases to arrive at the proposed DIG-HE model (Figure 1).

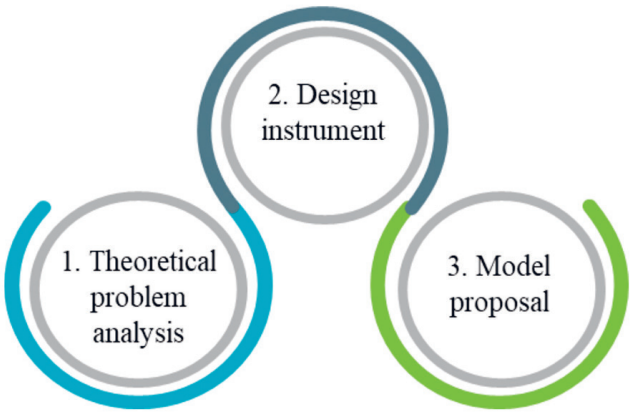

Fig. 1. Dig-HE Model Design Phases

Phase 1. For the theoretical problem analysis, a literature mapping and a systematic review of DT trends and the higher education context were conducted (Farias-Gaytan *et al*., 2021; Farias-Gaytan *et al*., 2023a), and the most prominent elements that interrelated both constructs were identified.

Phase 2. Questionnaire instruments were designed (Farias-Gaytan *et al*., 2023c; Farias-Gaytan, 2024) and implemented through interviews to analyze the experience HE institutions had on DT when implementing alternative credentials and digital education conducted as part of the qualitative approach (Farias-Gaytan *et al*., 2023b; Farias-Gaytan *et al*., under evaluation).

Phase 3. For the model proposal, the findings from the previous phases were integrated to propose a strategy for decision-making in HE (Ramirez-Montoya *et al*., under evaluation).

Results

The elements outlined below constitute a novel framework that outlines DT within HE. This model is grounded in both theoretical considerations and empirical evidence, derived from qualitative research tools. The framework encompasses four components, and it is shown in Figure 2.

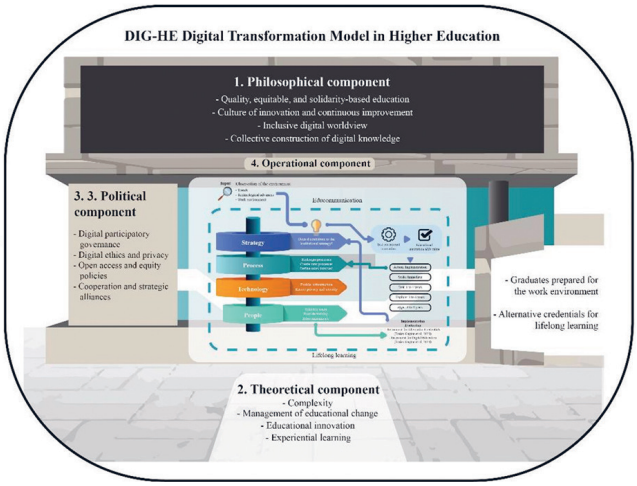

Fig. 2. DIG-HE Digital transformation model in higher education

Philosophical component.
The elements that make up this component are quality, equitable, and solidarity-based education, inclusive digital worldview, culture of innovation and continuous improvement, and collective construction of digital knowledge. HE has embraced DT as a means to incorporate innovation into their processes, as well as to stay relevant in the global context; however, it also requires financial resources for implementation and maintenance, which may exclude certain communities and even countries (Aguaded and Contreras, 2020; UNESCO, 2023). In this way, by taking into consideration these constructs, the promotion of decision-making focused on the common welfare from HE is encouraged, which will allow them to evolve and, in turn, respond to the challenges of a complex and constantly changing world.

Theoretical component.
This component considers the theories of complexity, management of educational change, educational innovation, and experiential learning. Based on the philosophical component in the face of a changing world, it is necessary to be aware of the complex environment from a holistic perspective of reality and to be capable of acting accordingly (Ramírez-Montoya et al., 2024). Likewise, educational innovation can help address new or existing situations and trends, and it is necessary to provide appropriate educommunication both within and outside HE to embrace change (Rof et al., 2020). These conceptual foundations provide a basis for integrating political constructs for their alignment.

Political component.
The proposed model considers the following constructs: digital participatory governance, digital ethics and privacy, open access and equity policies, and cooperation and strategic alliances to guide the processes in the educational context. This results in having the appropriate leadership that provides a clear vision of what is sought in HE, and the means to provide a safe environment where users, both internal and external, interact, since much of the technology has not been designed for educational purposes (UNESCO, 2023), and strive to have open practices to facilitate access to education for those who are excluded (Bossu and Ellis, 2023). Once you have the theoretical and political philosophical framework, the operation is proposed.

Operational component.
The operational component considers the elements for the successful implementation of the model. The proposed model (Figure 2) presents each element and how they are interconnected.

- Input: As a natural activity for HE, observing the environment provides new perspectives to stay relevant and be attentive to disruptions. From here arise initiatives for digital transformation to test.
- Strategy: Although in a preliminary phase, it is important to reflect on the value contribution of the initiative, test it, and determine the scope of the action to be taken based on the results, whether it be short-term (scale, test), medium-term (explore), or long-term (hype).
- Process: If an action is taken, it is necessary to review, adapt, and/or create processes for its incorporation into the institution, and to define the roles involved.
- Technology: The next step is to identify, assess, and select the technology that enables the action, aligned with the political component.
- People: Once the strategy, processes, and technology are in place, users are identified, training is provided, and educommunication is carried out.
- Implementation and evaluation: Instruments are applied to assess the initiative for digital transformation, and the results of its evaluation return to the strategy to determine if the initiative contributes to the institutional strategy. The validation cycle continues as many times as necessary depending on the type of action taken (short, medium, or long term).
- Output: As the ultimate purpose of the institution is to provide for the students the best experience to be prepared for the work environment with access to clear and transparent educommunication that guides those involved, considering that the institution's impact extends beyond its walls and is connected to lifelong learning.

Discussion

Digital transformation is a task undertaken by the HE to address pressing needs or explore innovative trends. The philosophical component represents the ultimate goals that HE aspires to quality, equitable, and solidarity-based education, inclusive digital worldview, culture of innovation and continuous improvement, and collective construction of digital knowledge (Figure 2). The flexibility in time and place offered by current technology has allowed access to educational resources for developing communities, and although it is tempting to implement all kinds of technological solutions, it is necessary to prioritize the educational purpose (Díaz et al., 2019; Tri and Hoang, 2023, UNESCO, 2023). The decision to embark on DT by HE should prioritize the aspirations of education due to its significance as a model for societal change.

The theoretical foundation consolidates and provides context for the actions to be carried out and sets the guidelines for addressing issues along the implementation path. This component included theories of complexity, management of educational change, educational innovation, and experiential learning (Figure 2). New trends such as alternative credentials and needs like lifelong learning are enabled by the digital transformation of HE which requires being prepared for these innovations and applying relevant pedagogical principles to ensure a quality experience (Corbeil and Corbeil, 2022; Hashim et al., 2022). HE's vocation to be part of society and for society implies being attentive to the issues that come with experimenting and exploring new ideas or artifacts, while safeguarding the integrity of its users.

HE is subject to the norms and policies of the society in which it is embedded. The political component refers to the constructs of digital participatory governance, digital ethics and privacy, open access and equity policies, and cooperation and strategic alliances (Figure 2). Governance acts as a regulator among the stakeholders and requires their active participation to ensure that technological changes align with established norms or, if necessary, to create new guidelines that consider ethical and privacy aspects (Rodríguez-Abitia and Bribiesca-Correa, 2021; UNESCO 2023). The model considers this component as a guardian that watches over safeguarding the purposes of education.

The implementation of DT initiatives requires planning and openness to an iterative and reflective process regarding the value they bring to HE. The operational component considers interconnected elements in a continuous cycle, and the model proposes having space for reflection and evaluation of DT initiatives to make informed decisions based on results (Figure 2). The model suggests considering strategy as a primary element, unlike Taher (2023) who presents the people-process-technology model. HE needs to evolve, but it must also be selective in the initiatives it invests in to ensure their relevance in providing quality education.

Conclusion

The present research aimed to answer the question: What are the components of a DT model that guides decision-making in HE to select the best path to remain relevant to society's needs? The findings identified were: (a) a philosophical component: quality, equitable, and solidarity-based education, inclusive digital worldview, culture of innovation and continuous improvement, and collective construction of digital knowledge; (b) a theoretical component supported by the theories of complexity, management of educational change, educational innovation, and experiential learning; (c) a policy component that refers to digital participatory governance, digital ethics and privacy, open access and equity policies, and cooperation and strategic alliances to guide the processes in the educational context, and (d) an operational component that interrelates strategy, process, technology, people, implementation, and evaluation with its inputs and outputs.

The DIG-HE model proposes an iterative approach for decision-making when selecting, implementing, and evaluating DT initiatives in HE which is important given the influx of new technologies, trends, and world changes that can create pressure or distractions when making the best decision. Having the appropriate stakeholders involved in a balanced way, and with a clear vision of the institution's goals and products, will give voice to all perspectives to assess the impact of transformation and address it effectively.

Regarding DT, the literature review can be fleeting, given the continuous flow of releases with new technological initiatives. Therefore, it represents a snapshot of the situation during a specific period and should be considered as such. The instruments used were applied each in one institution and they represent the participants' valuable experience, although the sample size was small. The present study is focused on HE, and it can be adapted to other educational levels. Further studies involve validating the model.

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ANEXO VI

Proceedings. Decoding the Enigma of a Digital Platform Transfer: Research-Based Design and Complex Thinking

Decoding the Enigma of a Digital Platform Transfer: Research-Based Design and Complex Thinking

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Abstract.
Cracking the code of digital learning environment transfer involves unraveling the complexities of migrating educational content and practices across diverse digital ecosystems, paving the way for a future where learning is seamless, adaptive, and universally accessible What are the key enigmatic pieces that need to be considered in the transfer of digital platforms? The research-based design method was applied, through the transfer of a digital platform developed in a research project in Mexico to a platform for a research project in England, with didactic components based on a model of complex thinking, computational thinking, digital transformation model for higher education institutions, and technological components with open resources. The data locates the key pieces of: (a) Educational internationalization, (b) Cultural localization, (c) Technological interoperability, (d) Learning analytics, ,(e) Pedagogical innovation, (f) Financial and operational sustainability. This study enriches the decision-making process by fostering the exchange and transfer of knowledge between institutions. It is intended to be of value to academic and research communities and developers interested in educational innovation processes.
Keywords: Complex Thinking, Educational Innovation, Higher Education.

1 Introduction

Nowadays, technology enables the learning path of students by providing options where they can interact with the teacher, their peers, and educational resources, and track their performance. Examples of this technology are technological platforms, which function as ecosystems for educational technology (Guillén-Yparrea *et al*., 2023). These platforms can be open or closed and allow educational institutions to offer online content and manage transactions that occur during the teaching-learning process such as communication, document exchange, and[3] activity execution (Salama and Hinton 2023; Tesla *et al*., 2020). For optimal utilisation, users, teachers, and students need to develop the appropriate competencies.

This should spark interest in continuing to learn to stay relevant, as well as to be prepared to use new digital products and services. Additionally, technology facilitates the development of other skills such as complex thinking (Alfaro-Ponce *et al*., 2023), which is essential for students because it provides a real perspective of the environment (Ramírez-Montoya *et al*., 2022). Regarding studies related to the transfer of educational platforms, research has been found on the adoption of Moodle (Learning Management System), which, being an open-source platform, can incorporate the development of new components (Karkar *et al*., 2020; Wallenborn *et al*., 2017); and on the transfer of didactic strategies and learning objects (Lim *et al*., 2022). This study seeks to answer the question What are the key enigmatic pieces that need to be considered in the transfer of digital platforms? Therefore, this study contributes to the literature by assisting decision-making and promoting the exchange and transfer of knowledge among institutions. The study first introduces the state of educational platforms, and the transfer processes. Next, the methodology, and the cases involved are presented; then the results and their discussion, conclusions and limitations.

1.1 Designing effective educational platforms

Currently achieving greater quality, equity, inclusion and relevance of Higher Education is a necessity at the international level. The development of a digital ecosystem allows for an intensive, rational and planned use of knowledge managed through digital platforms. The design of educational platforms has taken a new perspective in the wake of the Covid 19 pandemic, it is required to reposition online learning as a knowledge construction environment, for which teachers and designers incorporate new heuristics to create student centred online learning environments (Meier, 2021; Sanabria *et al*., 2022; Pérez et.al, 2020). Designs of this type require a multidisciplinary and professional team of designers and developers to program structural changes in the platforms that allow for creation and interaction options for students.

Digital ecosystems have defined a new social, economic, and cultural framework through the technological and innovative impulse of digital platforms that generate permanent interaction between users. Its design is mediated by infrastructure, services and applications, as central elements for the formation of these platforms. Digital transformation involves people, processes, strategies, technology, structures and competitive dynamics, so the design of a platform must consider the different roles of interactivity between the users of this, incorporating innovative technologies (Farias-Gaytan *et al*., under evaluation; Rodrigues, 2017). A platform that considers the structural needs and the different roles will allow the development of a digital ecosystem (Alfaro-Ponce *et al*., 2023), in particular it is possible to incorporate processes that help to scale complex thinking for problem solving through the various resources and tools offered by the platforms (Sanabria *et al*., 2023). Below, some of these experiences in processes of transfer of educational platforms are explored to identify the important elements to consider in a process of this nature.

1.2 Platform Transfer and complexity

Technology transfer processes must consider governance, operational, and technological aspects for mutual understanding between the parties. In this sense, effective knowledge transfer through a digital platform can accelerate the adoption of technology in teaching and learning complexity reasoning in Education 4.0 (Saba *et al*., 2023, Ramirez-Montoya *et al*., 2022). However, there are challenges that hinder knowledge transfer between higher ed-

[3] Esta comunicación ha sido remitida al comité evaluador de 12th *International Conference on Technological Ecosystems for Enhancing Multiculturality* (TEEM2024). University of Alicante. Spain.

ucation institutions, especially between continents, which have to do with the country's culture, communication between work teams of the institutions involved and the technological conditions of the place where knowledge transfer is implemented, among others (Lim *et al*., 2022; Leder *et al*., 2023). Therefore, delimiting the elements to be considered in the transfer process and the strategies to incorporate them are the basis of a successful transfer process.

The strategies identified to realize an effective knowledge transfer process between higher level institutions facilitate continuous, timely and bidirectional needs assessment and information feedback between organizations and countries (Yehorchenkova *et al*., 2020; Lu, 2020). Technology transfer processes allow supporting the co-construction of digital solutions with partners identified according to their ecosystems and self-learning modules allow each learner to expand their knowledge of complex thinking. For this study, the following indicators will be considered as part of the methodological process of technology transfer: educational internationalization, cultural localization, technological interoperability, learning analytics, pedagogical innovation, financial and operational sustainability.

2 Method

This study used two methodologies, design-based research and complex thinking design, both applied to the educational context. Design-based research encompasses a series of iterations to solve real-world problems with the participation of researchers and practitioners working in collaboration (Wang and Hannafin, 2005). To carry out these interpretations of reality and develop solutions, it is necessary to have the appropriate competencies. Complex-thinking design represents the ability to interconnect various dimensions of reality, replacing linear causality with an understanding of the integration of a whole (Ramírez-Montoya *et al*., 2024a). Both methodologies share a common goal to enhance learning experiences and outcomes by designing educational interventions that are deeply rooted in theory and practice.

2.1 Case: Tecnologico de Monterrey

The E4C&CT (Ecosystem for Scaling up Computational Thinking and Reasoning for Complexity) platform was developed at Tecnologico de Monterrey, to emulate real-world scenarios of varying complexities, leveraging Artificial Intelligence to integrate three main components: data management, data visualization, and intelligent analytics processes. This digital ecosystem aims to enhance computational problem-solving skills among undergraduate and graduate students enrolled in STEM programs, particularly in Latin American universities. The platform, accessible through http://e4cct.mx/, includes modules designed to develop four key sub-competencies of computational thinking: decomposition, pattern recognition, abstraction, and algorithms. These modules are structured to help users break down complex problems, identify trends, simplify issues, and develop step-by-step solutions, respectively. The platform's design also incorporates gamified instructional methods to engage learners effectively, providing a comprehensive framework to foster essential skills for addressing 21st-century workplace challenges.

2.2 Case: King's College London

The Project Development of CDIO (Conceive, Design, Implement and Operate) module on Electric Vehicle Powertrains (EVL) (Project ID: IND/CONT/G/23-24/A1 (G/22-23/19) funded by British Council, UK) is a joint collaboration between Vellore Institute of Technology (VIT) India, Aston University and King's College London (KCL), UK which has resulted in a strong platform to work together in the Electric Vehicle powertrains sector with support from Ather Energy Private Limited, a leading electric two wheeler manufacturer in India. One product of this collaboration has been the development of course materials on this topic for students in India, however the aim is to make them available for public utility across the globe. The course module "Electric Vehicles Powertrains" has already been prepared and delivered to the undergraduate and master students of VIT as short term course, workshop, seminar, industry expert talk, foreign expert lecture face to face with excellent support from leading automakers of India like Ashok Leyland, Ather Energy, Renaults Nissan, Devise Electronics etc., and which have reached nearly 400 students of VIT among all streams including mechanical, electrical, electronics and computer science engineering.

2.3 Procedure

In the academic world, problems serve as a catalyst to bring together experts and collectively design a solution. This study combines theoretical foundations and product development to provide solutions to real-world problems which need to be validated through scientific research (Pernaa *et al*., 2022) (Fig. 1).

Fig. 1. Procedure to define the transfer of the digital platform.

1. Theoretical foundations: an analysis of literature review was conducted regarding digital transformation trends in higher education context (Farias-Gaytan *et al*., under evaluation) to identify best practices, trends, and challenges faced about digital platforms and on complex thinking design (Ramirez-Montoya *et al*. 2024a).
2. Solution development: it refers to the development of the process of transferring the digital platform suitable to the needs of the receiving institution (Farias-Gaytan *et al*., under evaluation).
3. Solution implementation: Includes the delivery of the digital platform and the implementation of a tool to measure the user experience on the digital platform. (Ramírez-Montoya *et al*., 2024b).

3 Results

The development of the transfer process was not unidirectional, but rather required active participation from all parties to select the best solution (Fig. 2).

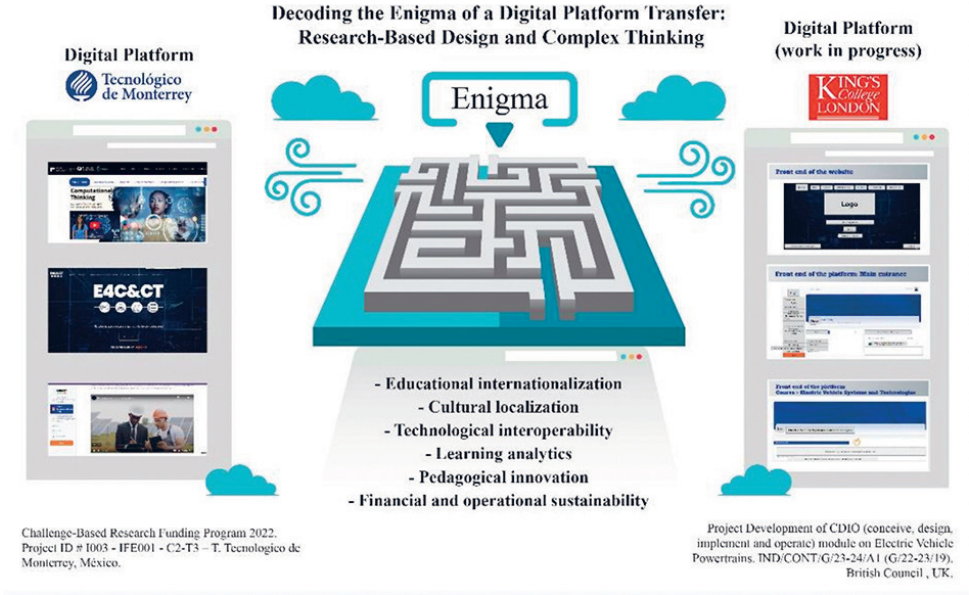
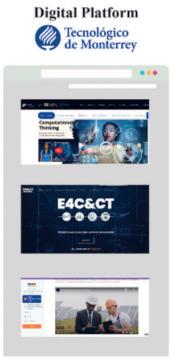


Fig. 2. Digital platform transfer process

3.1 Digital platform Tecnologico de Monterrey



The implementation of the E4C&CT platform was carried out across diverse countries and educational contexts, focusing primarily on higher education institutions in Latin America. The data collected between February 7, 2024, and May 14, 2024, from 463 participants revealed significant insights into the demographics and academic disciplines of the users (Figure 3). Most participants were young (24.4 years average), predominantly male (89.5%), and primarily from Mexico (81.1%). The platform saw substantial engagement from students in Engineering and Technology (58.3%) as shown in Figure 4. This extensive implementation facilitated the enhancement of computational thinking and problem-solving skills among students, aligned with the platform's goal to prepare them for the complexities of the 21st-century workforce.

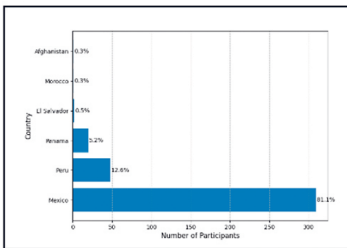


Fig. 3. Number of participants per country.

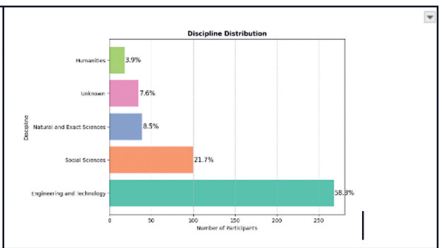


Fig. 4. Number of participants with discipline.

3.2 Digital platform King's College London

For the adaptation of the digital platform, the project planning was carried out. The design involved defining the Front-end of the platform, the navigation elements of the Home page, and the elements of EVL course. Regarding the didactic structure, the learning path was outlined, which includes pre and post assessments on the topic of EVL and in the domain of complex thinking.
The design of the online EVL course included the structure of the formative experience based on a cognitive mastery level of knowledge, considering 10 hours invested by the participant. The profile of the participant consists of English-speaking undergraduate students with little to no knowledge of EVL, coming from different countries The course content was designed by a group of experts in EVL trained on the platform's functionalities and instructional content design. Developers implemented adjustments to the platform, and assembled the educational content and resources.

4 Discussion

The successful implementation of the E4C&CT platform in diverse educational contexts suggests that technological interoperability is a critical factor for the scalability and adaptability of educational technologies across different domains. Figure 3 illustrates the distribution of participants from various countries, emphasizing the platform's ability to function effectively across diverse geographic regions. This finding is supported by previous studies, such as those by Anderson and Dron (2011), which highlight the necessity of robust interoperability standards in educational technology to ensure seamless integration and functionality across different systems and environments. The implications for practice and research are significant, suggesting that platforms designed with interoperability in mind are better suited for international and cross-disciplinary applications, such as the transition to an electric vehicle education platform at King's College London.

Learning analytics provide valuable insights into student engagement and learning outcomes, facilitating data-driven decision-making and personalized learning experiences. Figure 4 demonstrates the distribution of participants across various disciplines, underscoring the broad applicability of learning analytics in understanding and enhancing educational experiences in diverse fields. This aligns with the theoretical perspectives of Siemens (2013), who advocates for the integration of learning analytics to foster adaptive learning environments that respond to individual learner needs. For practitioners, the integration of learning analytics into educational platforms can lead to more informed instructional strategies and improved student outcomes, while researchers can explore the longitudinal impacts of data-driven interventions on learner success.

Pedagogical innovation is essential for creating engaging and effective learning experiences, and the E4C&CT platform's success highlights the importance of innovative instructional design in modern education. The diverse disciplinary backgrounds of the participants, as shown in Figure 4, indicate that the platform's pedagogical strategies are effective across a wide range of academic fields. This finding resonates with the work of Laurillard (2012), who emphasizes the role of pedagogical innovation in leveraging technology to enhance learning and teaching practices. The implications for practice include the need for educators to adopt and adapt innovative pedagogical approaches to meet the evolving needs of learners, while researchers can investigate the specific elements of instructional design that contribute most significantly to student engagement and learning outcomes in various educational contexts

Educational internationalization implies adapting and transferring educational programs, including courses and platforms, to different cultural and linguistic contexts. It is necessary to make these adaptations in order to provide a quality experience for the participant (Fig. 2). This has implications for educational practice, as it requires being sensitive to specific needs and also to the global community in order to develop open and inclusive educational resources (Ramírez-Montoya *et al*., 2024b). For practitioners, this requires rethinking current pedagogical practices and methods to adapt to the needs and expectations of new users.

Cultural localization encompasses the adaptation of educational and technological materials to the local culture of the new context. The dialectical process between the parties for diagnosing the project's needs and developing customized elements ensured that the courses and platform were culturally relevant and accessible (Fig. 2). This is important because cultural differences increase among geographically distant groups (Lim *et al*., 2022). For practitioners, this requires balancing the design considering the characteristics of the whole group while providing specific resources that are relevant to the individual.

Financial and operational sustainability: It is essential to have the necessary funds to cover transfer costs, technological upgrades, maintenance, installation, and operation of the technologies This is relevant because the platform is expected to have global reach, and although its use is limited to the duration of the course, the impact of numerous concurrent users can be an obstacle to its proper functioning (Fig. 3). It is necessary to include strategies in the project planning to prevent its obsolescence so that it can continue operating successfully (González-Pérez *et al*, 2020) The implications for practice include developing business cases that estimate the project's lifespan and the required human, technological, and financial resources for its deployment.

5 Conclusions

This study aimed to address the research question: What are the key enigmatic pieces that need to be considered in the transfer of digital platforms? The findings showed six key pieces: (a) Educational internationalization, (b) Cultural localization, (c) Technological interoperability, (d) Learning analytics, (e) Pedagogical innovation, (f) Financial and operational sustainability. This study contributes to the literature by assisting decision-making and promoting the exchange and transfer of knowledge among institutions. Therefore, the implications for practice and research are significant since it serves as a foundation for other institutions because it considers strategic aspects such as having a vision and project definition, as well as the means to carry it out; in addition to establishing processes to create the stipulated products, and having the necessary technology to ensure seamless integration and functionality across different systems and environments; just as, the training of key roles for the design and development of course content and the platform.

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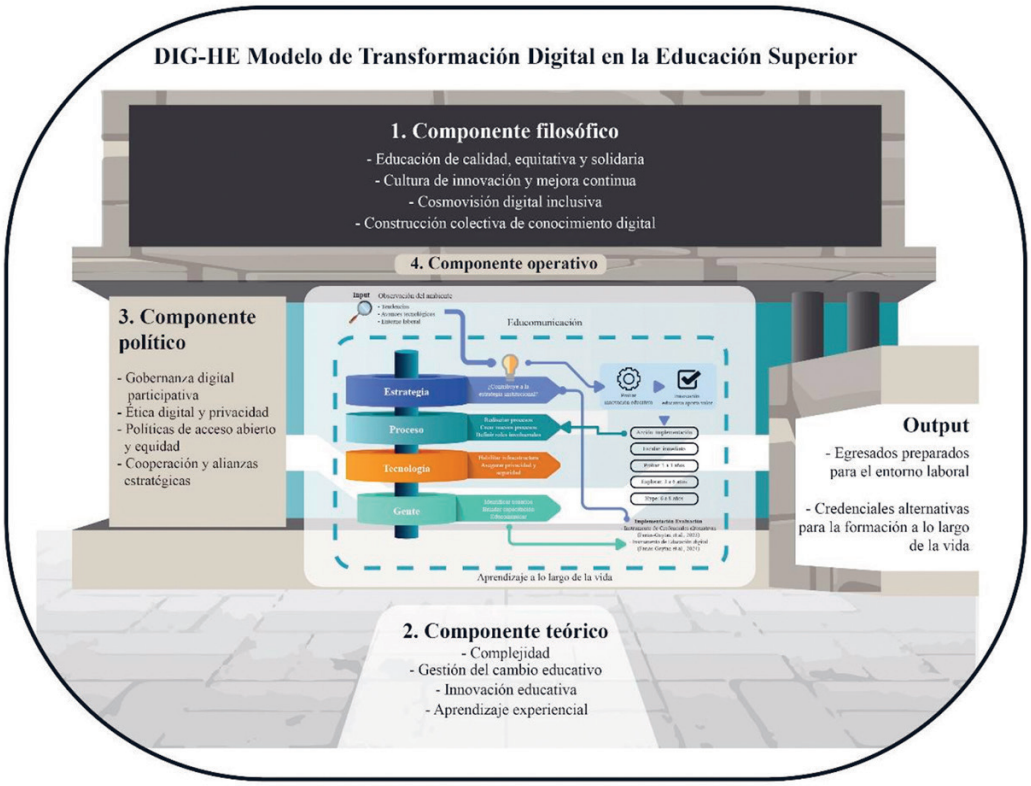
ANEXO VII

Modelo de transformación digital en la educación superior



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DIGITAL

TABLA DE PUBLICACIONES

ARTÍCULOS PUBLICADOS EN REVISTAS CIENTÍFICAS INDEXADAS

Título	Revista	Autores	Indexación	Fecha	DOI
Transformation and Digital Literacy: Systematic Literature Mapping	Education and Information Technologies	Silvia Farias-Gaytan Ignacio Aguaded Maria-Soledad Ramirez-Montoya	JCR-JCI (2023): Q1 Education Impact factor 4.8 CiteScore (2023): 10.0 Q1 Education 96%/1543	2021-07-15	10.1007/s10639-021-10624-x
Educational Innovation with Alternative Credentials as a Driver of the Digital Transformation of the University: A Case Study in Latin America	Journal of Interactive Media in Education	Silvia Farias-Gaytan Maria-Soledad Ramirez-Montoya Ignacio Aguaded	JCR-JCI (2023): ESCI Communication Impact factor 3.0 CiteScore (2023): 6.4 Q1 Communication 89%-53/511	2023-05-24	10.5334/jime.793
Digital transformation and digital literacy in the context of complexity within higher education institutions: a systematic literature review	Humanities and Social Sciences Communications	Silvia Farias-Gaytan Ignacio Aguaded Maria-Soledad Ramirez-Montoya	JCR-JCI (2023): Q1 Education Impact factor 3.7 CiteScore (2023): 10.0 Q1 Education	2023-07-07	10.1057/s41599-023-01875-9

ARTÍCULOS EN PROCESO DE REVISIÓN EN REVISTAS CIENTÍFICAS INDEXADAS

Título	Revista	Autores	Indexación	Fecha de envío
Evaluation of the digital transformation of a Latin American higher education institution by incorporating digital education	Frontiers in Education	Silvia Farias-Gaytan Ignacio Aguaded Maria-Soledad Ramirez-Montoya	JCR-JCI (2023): Q2 Education Impact factor 1.9 CiteScore (2023): 2.9 Q2 Education 62% 580/1543	2024-04-30

ARTÍCULOS DE FUTURAS PUBLICACIONES EN REVISTAS CIENTÍFICAS INDEXADAS

Título	Revista	Autores	Indexación
DIG-HE: validity and reliability of model for assessing digital transformation of Higher Education	New Media & Society	Silvia Farias-Gaytan Ignacio Aguaded Maria-Soledad Ramirez-Montoya	JCR-JCI (2023): Q1 Communication Impact factor 4.5 CiteScore (2023): 12.7 Q1 98% 18/1466 Sociology and Political Science
Estado de la transformación digital en educación superior en Iberoamérica: Caso de estudio	Review of Educational Research	Silvia Farias-Gaytan Ignacio Aguaded Maria-Soledad Ramirez-Montoya	JCR-JCI (2023): Q1 Education Impact factor 8.3 CiteScore (2023): 24.1 Q1 99% 2/1543 Education
Nuevas competencias digitales derivadas de la transformación digital en educación superior: método mixto	Communication Research	Silvia Farias-Gaytan Ignacio Aguaded Maria-Soledad Ramirez-Montoya	JCR-JCI (2023): Q1 Communication Impact factor 4.9 CiteScore (2023): 24.1 Q1 99% 3/1088 Language and Linguistics

COMUNICACIONES EN CONGRESOS PUBLICADAS

Título	Conferencia	Autores	Fecha	DOI
Research plan on the digital transformation of faculty to advance to the global era	TEEM'20: Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality	Silvia Farias-Gaytan Ignacio Aguaded Maria-Soledad Ramirez-Montoya	Octubre 2020	10.1145/343478 0.3436634

COMUNICACIONES EN CONGRESOS EN PROCESO DE REVISIÓN

Título	Conferencia	Autores	Fecha	DOI
DIG-HE Digital Transformation Model in Higher Education: An Implementation Model	12th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM2024). University of Alicante. Spain.	Silvia Farias-Gaytan Ignacio Aguaded Maria-Soledad Ramirez-Montoya	Octubre 2024	En proceso de revisión
Decoding the Enigma of a Digital Platform Transfer: Research-Based Design and Complex Thinking	12th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM2024). University of Alicante. Spain.	M.S. Ramírez-Montoya I. Aguaded R. Tariq T. Wilberforce M. Martínez-Reyes S. Farias-Gaytan	Octubre 2024	En proceso de revisión

LIBRO PUBLICADO

Título	Editorial	Autores	Fecha	DOI
Guía de indicadores de calidad para recursos educativos digitales: GIC-RED	Asociación Nacional de Universidades e Instituciones de Educación Superior	María Luisa Zorrilla Abascal Silvia Catalina Farías Gaytán Claudia Marina Vicario Solórzano coordinadoras	Diciembre 2023	https://publicaciones-tic.anuies.mx/

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