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Digital Transformation in Higher Education Institutions

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Prologue

“The Times They are a-Changing...”

—Bob Dylan

The title of this prologue is a song written by Bob Dylan and was released as the title track of his 1964 album of the same name. It became famous during a time of countercultures, political changes including the civil rights movement and the beginning of environmental consciousness.

During that time the youth were proclaiming a world of “peace, love and hope”. They were hoping for a world that would stop using them as machines in factory production lines and stop using them as soldiers in wars. They hoped for a world where they could live in peace and harmony with each other and with nature.

However, their plight was not heard at that time. The education models continued as before. Students were expected to sit in rows and expected to watch demonstrations and to memorize and regurgitate the knowledge they learned. Continuously being kept in a system that did not promote creative and out-of-the-box thinking.

Fortunately, world and religious leaders became aware of the need for change and organizations such as UNESCO (1945), the World Bank (1944), Let No Child Left Behind (NCLB) (1965), Bread for the World (1974) as well as the European Union (1992) and the African Union (2002) were founded. Political systems and economical systems transitioned from socialist to liberal-democratic systems (Fukuyama, 2020), promoting education to the poor and uneducated.

However, even though education became available to more children, the actual education systems stayed as traditional as before. Churning out young people for the work force to fill jobs applying the same behaviorist pattern they had learned.

And then 20 years later something happened in the field of communication information technology (ICT). The World Wide Web or Internet as we know it was invented by a British computer scientist, Tim Berners-Lee, using a global hypertext document system that could establish communication which aimed at uniting researchers and would offer open access to all (Berners-Lee, 1989).

From then on more Education systems started incorporating computer technology as they could see the value of students being part of their own learning and searching for information on their own (Agarwal & Day, 1998; Lenhart et al., 2001; Ramani, 2015).

Another triumph for the hope of change came at the turn of the century when technology became mobile and teaching and learning became ubiquitous and self-directed (Kinshuk & Graf, 2012). Teachers started flipping their classrooms (Bishop & Vergelegen, 2013); changing them to group seating and moving (Renard, 2020; Alik & Arabi, 2021) from teacher-centered learning to student-centered learning (Garrett, 2008). However, many educators and policy makers still had their reservations to move from their traditional approach (Peters, 2010).

At the same time and specifically since November 2022 the world was introduced to Internet-based intelligence applications that would change education, economies and policies into a new era, namely, Generative Artificial Intelligence (Agrawal et al., 2019; Williams, 2023; Chan, 2023).

Besides existing search engines such as Google and Bing, these AI systems offer opportunities to lecturers, students, businesses, architects, artist, doctors and even politicians to research and assist them with every day, tedious tasks and turn them out within minutes. Tasks such as designs, documentation, contracts, diagnosis curricula, writing letters, creating images and many more.

Do the changes mean that human kind is getting closer to achieving a society where humans can learn more about each other by having access to more knowledge, resources and communication opportunities? Will these technological advances introduce a new era where social and emotional as well as economic well-being can be addressed and solved?

The title of this book *Digital Transformation in the Higher Education Institution*, as presented in each chapter, indicates the impact of transitioning and integrating technology into Higher Education. The study also indicates how these changes in the Higher Education Landscape are of utmost importance for student's preparedness to transition into the world of work. These changes offer knowledge and opportunities in education and thereby opportunities to improve prosperity for all.

For example, using technology as simple as a smartphone can seamlessly connect us from the sofa of our home or even from a taxi to AI. It can also connect us with every service we need or can contribute to (Hambrock & De Villiers, 2023). Thus, transforming learning and teaching as well as our lifestyle to a seamless experience.

Other possible advantages of using generative AI could be to cut down on unnecessary time spend on tedious work so that school and work could start an hour later and end an hour earlier. Families could spend more time together and more time could be available for social and community gatherings to improve general wellbeing of humans.

Would this mean that a future where peace, love and hope could be achieved because humanity no longer has to fight over resources on a micro-level as they can rather work together for a world where the global environment would thrive and be alive for future generations? Could this change restore our natural environment so that it could in turn take care of humanity again?

Perhaps soon, these changes could be added as a last verse to Bob Dylan song: “The times have changed from war, hunger and poverty. To peace, love, hope and prosperity for all”.

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Presentation

Developing a virtual culture in universities will require imaginative and creative implementation, as well as open leadership and an innovative mindset. Learning technology cannot be seen as a mere utility, but as an academic opportunity. Pedagogical design, multimedia production and data analysis are vital.

The evolution of the digital world, or a new technological breakthrough, or even a drastic change in the demands of the education market – the “educational technology phenomenon” – would have caused the gradual change we are witnessing. But not a virus. COVID-19 has redirected and amplified the concerns and actions of universities around the world, reshaping and challenging their interests in order to guarantee operational continuity in the short term, while ensuring institutional viability in the long term.

In this scenario, the behavioral changes that have emerged in the younger generations have inevitably led to the reformulation of learning itself. Consequently, teaching methodologies are being updated to keep up with the technological evolution of learning and, above all, to train future professionals for the job market and their professional careers.

In this context, there has been a digital transformation in higher education with the use of information and communication technologies. This transformation has led to the use of different technologies, including artificial intelligence (AI). The use of AI in higher education can provide personalized education through the automation of administrative teaching tasks, software programs that help detect topics that need reinforcement in the classroom, guidance and support for students outside the classroom and the intelligent use of data to teach and support students. In addition to providing personalized teaching using augmented reality, adaptive platforms, intelligent tutoring systems, chatbots, adaptive learning, computer-assisted instruction, direct feedback, Moocs and Robotics. So the questions in this ebook are:

How will the digital transformation take place in higher education? How can digital transformation be implemented in higher education? What are the links between Artificial Intelligence and the COVID-19 pandemic in the transformation of higher education? How can universities promote actions to implement digital transformation? What sustainable educational technologies can be used in the

teaching-learning process for students? How can Blockchain technology and artificial intelligence be applied in higher education? How the metaverse can be applied in virtual learning environments in higher education? This book will present some situations in order to improve, enhance and qualify sustainable education through digital technologies.

The first chapter, entitled “Digital Transformations: Artificial Intelligence in Higher Education”, by the authors Andreia de Bem Machado, João Rodrigues dos Santos, António Sacavém and Maria Jose Sousa, explains the applicability of artificial intelligence in higher education. Its aim is to map the digital transformation and the application of artificial intelligence in higher education. A bibliometric survey was carried out on the Web of Science database. The findings show that artificial intelligence can be applied to higher education through a smart contract that encourages collaboration between students and participation in extracurricular activities, as well as increasing machine reliability by creating a chain of information. In addition, it has been decided that this technology will help train a generation prepared to cooperate more and adopt sustainable attitudes to solve difficult everyday problems in the twenty-first century.

The second chapter entitled “Educational Institutions: Artificial Intelligence and Blockchain in Higher Education”, by the authors Andreia de Bem Machado, Maria José Sousa, Gertrudes Aparecida Dandolini and Leonor Domingos aims to map, through a scoping assessment, how Artificial Intelligence and Blockchain can be used in education as a technology for higher education. It concludes that these technologies will contribute to the development of a generation prepared to work more co-operatively and adopt sustainable attitudes in local and global contexts to deal with the complicated issues of modern life.

The third chapter, entitled “Digital Transformation in Higher Education Institutions: A Case Study at Polytechnic University of Tomar”, by the authors Célio Gonçalo Marques, Lígia Mateus and Inês Araújo, aims to report on a case study of the creation of digital educational content for the Polytechnic University of Tomar (IPT) using an agile learning approach. The process involves several stages, including planning, course design, content production, course creation on the project platform and course launch. This streamlined process simplifies content production and allows more teachers to integrate interactive learning materials into their teaching practice.

The fourth chapter, “Federal Public Policy and Digital Transformation in Higher Education”, by Welinton Baxto, describes federal public policy and digital transformation in higher education. The findings point to the application of information and communication technologies in order to diversify access to formal education in the different regions of the country. The conclusion is that the federal government’s guidelines are aimed at improving the teaching and learning process in higher education. However, it is in the process of fulfilling goal 12 of the National Education Plan, which refers to “democratizing access to higher education, with inclusion and quality”. On the other hand, 9 years after the approval of the National Education Plan, new discussions are being held about the scope or otherwise of Law 13.005 of June 25, 2014.

The fifth chapter, “Augmenting Open and Distance Learning Through Gamification”, by authors S K Pulist and Ramesh Chander Sharma, aims to investigate the pedagogy of gamification and how the gamification design framework can support active learning, performance monitoring and instant feedback. It concludes that gamification has been used in industry to increase productivity and acquire skills. And the instructional approach and nature of open and distance education study materials cater for the independent learner.

In the sixth chapter, entitled “Exploring the Potential of Gamification in Omani Higher Education Institutions: A Case Study of UTAS Salalah, Oman”, by author Dr. Sangeeta Tripathi, the research examines the use of gamification in higher education institutions in Oman, with a specific focus on the University of Technology and Applied Sciences (UTAS) in Salalah. The results indicate that gamification has positively impacted student engagement, motivation and learning outcomes in a number of areas; however, there are some challenges faced by faculty members during the implementation of gamification, such as the need for training and support.

The seventh chapter, “Usages of ChatGPT in Higher Education: A Study with Graduate Students”, by the authors Rogério Costa, Adriana Lage Costa and Ana Amélia Carvalho, aims to investigate how students use ChatGPT and their perspective on its functionality. A sample of 375 postgraduate students took part in the research, 76.5% of whom were female and 23.5% male. Most of the participants were master’s students, while 22.4% are enrolled in a doctoral program. More than half of them (59.7%) reported using ChatGPT mainly in the academic context, followed by the social and professional context.

The eighth chapter by Paolo Biancone and Federico Chmet, entitled “Role of ChatGPT in Accounting”, aims to examine the use of ChatGPT in accounting, highlighting its benefits and challenges. It explores how ChatGPT can simplify tasks ranging from data entry to preparing financial reports, while acknowledging data security and system integration concerns. It also highlights the evolving role of accounting professionals who can take advantage of ChatGPT for more in-depth analysis and strategic advice. Despite the fact that there are currently limitations in educational and professional contexts due to errors and limitations in thinking, this chapter highlights the continuous evolution of technology.

The ninth chapter, “A Review ChatGPT and the Future of Education,” by the authors Andreia de Bem Machado, Antonio Pesqueria and Maria Jose Sousa, aims to map the future of education through ChatGPT in the context of a bibliometric review. It concludes that ChatGPT, which is used in various socio-economic areas, has been found. In the future of education, teachers and students will be able to use it. This ChatGPT can be used for various things, such as instruction and training, entertainment, question prediction, appointment setting and code debugging.

The tenth chapter, “Neolearning as a Methodology that Advances from Experiential and Expansive Learning Theories to Practice”, by the authors Graziela Grandó Bresolin and Patricia de Sá Freire, aims to analyze neolearning as a methodology that advances from experiential and expansive learning theories to practice. The results show student satisfaction with the application of the methodology in

class, which provides greater motivation and applicability of the content in class, and teacher training to innovate in the classroom.

In the eleventh chapter, “Adopting Blockchain for Educational Qualifications in Italy: The Experience of the University of Turin”, by the authors Katia Presutti and Francesca Natale, aims to provide an overview of blockchain in the Italian education system, addressing the main issues of stakeholders.

The twelfth chapter, entitled “Competences and Soft Skills in Higher Education: Innovation in the Assessment of University Students’ Learning Outcomes”, by Francesca Di Virgilio, presents the TECO (TEst on Competences) project, which focuses on meeting the needs of emerging sectors, innovative sectors and the promotion of student-centered teaching, accompanied by the analysis of learning outcomes, to accompany Italian higher education’s bid for a sustainable and inclusive economic recovery.

Digital technologies and their applications have drastically transformed the world economy and global companies. The context also indicates that the growing market competition requires higher education institutions (HEIs) to transform their management structures and strategies. It is possible to see that this scenario of change has caused some traditional HEIs to focus their efforts and analyses on themselves, assuming that cost-cutting actions, reorganizing structures and digitizing classes are enough.

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Digital Transformations: Artificial Intelligence in Higher Education



Andreia de Bem Machado, João Rodrigues dos Santos, António Sacavém,
and Maria José Sousa

1 Introduction

The world of today is undergoing rapid change, making “invention” a crucial life skill. In this context, it is considered that the many socio-ecological issues that have arisen in the digital age have presented unique difficulties for society and call for creative solutions across all facets of society. This makes artificial intelligence an interdisciplinary field that focuses on the study, creation, and application of tools and methods for simulating, enhancing, and extending human intelligence (Zhong et al., 2018). It is possible that mankind is about to experience a new socio-technical paradigm that will have an unparalleled impact on world civilization and present prospects for transformation in many traditional economic areas.

The Dartmouth Society first introduced the idea of artificial intelligence in 1956 (Dodigovic, 2007), and since then, it has been used in a growing number of spheres of our life, including the setting of education. Building intelligent machines and artifacts, or at least ones that behave intelligently, is the goal of artificial

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intelligence. Artificial intelligence technology is a crucial branch of computer science that focuses on the study and advancement of technical disciplines used to mimic, amplify, and extend human intelligence. Artificial intelligence has ushered in an explosive era in recent years because of the great strides made in machine processing and machine learning as well as the exponential growth of data. Artificial intelligence has the potential to radically transform several sectors, including security, banking, retail, transportation, and education, thanks to its advantages in analysis, prediction, judgment, and decision-making.

Therefore, the objective of this research is to map digital transformation and artificial intelligence in higher education. To achieve this goal, we performed a bibliometric review. This research is divided into six parts: The first is the introduction, the second explains the digital transformation theme, the third addresses artificial intelligence, the fourth the methodology adopted, the fifth part discusses digital transformations: artificial intelligence in higher education, and, finally, the final considerations of the authors.

2 Digital Transformation

Digital transformation refers to the integration of digital technology into all organizational areas, changing how operations are conducted and the way value is delivered to customers (Berman, 2012). It is not just a buzzword or about updating the technology within an organization, but about reshaping the organization's culture and operations to embrace continuous change (Bounfour, 2016). Indeed, digital transformation entails a fundamental shift in how businesses operate and deliver value since is driven by a multitude of factors, namely: increasingly pervasive and interconnected digital technology, changes in customer behavior and expectations, and the emergence of innovative business models (Matt et al., 2015). A holistic and strategic approach is critical for a successful transformation, which considers technology, data, process, and organizational change. In this scenario, one of the most comprehensive and balanced interpretations views digital transformations as a progressive process that utilizes digital technologies and abilities to create value-driven business models, enhance business practices and operations, and improve service delivery (Morakanyane et al., 2017).

The digital age has created a profound impact on organizations. Those failing to adapt and evolve face the risk of falling behind in the competitive landscape (Kane et al., 2015). Nowadays, organizations need to harness the power of digital transformation to improve business processes, corporate culture, and customer experiences to meet organizational change and market requirements (Westerman et al., 2011). The significance of digital transformation reaches into the sphere of higher education, where it can notably improve the learning experience by making it more accessible, engaging, and efficient. By adopting digital transformation, higher education institutions will be more equipped to cater to the evolving demands of students and the wider academic society. One of the universities purposes has changed to training

future managers to tackle issues and look for solutions, including information literacy (Akour & Alenezi, 2022). Therefore, institutions are leveraging technology to enhance learning experiences, streamline administrative tasks, and promote innovative research practices (Daniel, 2015).

If there is a comprehensive understanding of the skills required for the future and how universities are training students to acquire these skills, it would lead to enhancements in teaching, learning, and university functions, benefiting all involved parties. This understanding is particularly crucial given the rapid pace of workplace transformation (Alenezi, 2021). In the face of evolving technology, it is vital for higher education institutions to navigate the uncertainty in establishing robust and adaptable educational support systems that meet both educational goals and future employment needs. Universities remain key in preparing students with the necessary skills for success in the twenty-first-century workplace. However, the swift pace of technological advancement is posing challenges for these institutions in effectively planning, strategizing, and predicting a spectrum of educational goals (Akour & Alenezi, 2022). To continue playing a significant role in preparing students for future careers, they need to overcome these challenges. As a result of technological progress, educational institutions may find themselves needing to prioritize courses that focus on technical, advanced cognitive, knowledge-based, and digital skills, potentially overshadowing more holistic, cooperative, multidisciplinary, and cross-cultural learning methods. Some also argue that technology is reshaping the dynamics between students and institutions in terms of learning expectations and requirements. This has spurred the growth of competitive and alternative learning methods, fostering more flexible, comprehensive, and personalized learning experiences (Akour & Alenezi, 2022).

Digital transformation has made higher education more accessible and flexible. Innovative technologies like ubiquitous and pervasive computing, smart devices, along with the proliferation of massive open online courses and extensive use of social media, are driving the digital transformation, which is fundamentally altering the methods and accessibility of teaching, learning, and assessment (Bamiah et al., 2018). This flexibility is particularly beneficial for non-traditional students who may be balancing education with work or family responsibilities.

Digital resources like interactive simulations, virtual reality, and collaborative online platforms can significantly enhance student engagement and collaboration (Bonk & Khoo, 2014) since these tools can make learning more interactive and fun, thereby improving student motivation and learning outcomes. Additionally, given the pervasive presence of social media in a student's daily life, it can serve as a potent instrument in facilitating teaching, peer interaction, and communication with instructors. The utilization of social media promotes student involvement, peer interaction, and student-teacher engagement (Akour & Alenezi, 2022). Creating strategies to encourage, foster, and stimulate the use of social media in a virtual learning setting, along with offering efficient implementation and oversight for educators adopting social media more extensively, could be beneficial for both students and teachers, leading to superior results in educational institutions (Bozanta & Mardikyan, 2017). Furthermore, adaptive learning systems and learning analytics

can provide real-time feedback to students and instructors, enabling them to effectively adjust to the learning process. Moreover, digital transformation enables personalized learning, because teaching is tailored to each student's unique needs and distinctive learning pace (Becker et al., 2018).

Several studies have scrutinized the efficiency of students' engagement with e-learning platforms, focusing on their dependence on, acceptance of, and incorporation of technology into academic tasks. The patterns of study differ, and students' perceptions of the platforms' usefulness and user-friendliness influence their willingness to use them effectively (Moreno et al., 2017). As a result, educational institutions should promote and facilitate the incorporation of e-learning platform features into instructional activities (Akour & Alenezi, 2022).

Digital transformation has the potential to boost research abilities in higher education. Tools such as digital databases, data analytics, and cooperative research platforms can streamline, improve the research process (Borgman, 2017), and assist researchers in swiftly and precisely analyzing extensive datasets, resulting in more substantial research conclusions (Dwivedi et al., 2020). Furthermore, digital transformation can promote international cooperation, enabling researchers worldwide to collaborate more effectively, and it can also facilitate instantaneous data gathering and examination, resulting in more precise and prompt research findings (Mohamed Hashim et al., 2021). Finally, digital transformation could offer a heuristic model to foresee potential risks and opportunities for researchers, adding to the discussion about the implications of digital transformation on public higher education and research (Barzman et al., 2021).

Despite its necessity and outstanding opportunities, digital transformation is not an easy task. Many organizations face significant challenges, such as resistance to change, lack of digital skills, and the complexity of integrating new technologies into existing infrastructures (Verhoef et al., 2021). Digital transformation in higher education also poses challenges. These include the resistance to change, the need for upskilling staff, the financial cost of implementing new technologies, and concerns over data privacy and security (Selwyn, 2013). According to Alenezi (2021), the digital transformation challenges in higher education institutions are: prioritization; decentralized decision-making; human resistance to change; gaps in digital tech talent, and narrow view of ROI. Universities often concentrate on pressing issues at the expense of significant ones, prioritizing immediate outcomes while delaying crucial investments in capacity building that require time. It's argued that the approach to planned digitization is neither particularly innovative nor adequately funded (Rodríguez-Abitia & Bribiesca-Correa, 2021). Decentralized decision-making can lead to postponements in executing extensive decisions and projects. Conversely, IT systems governed by centralized control and decision-making tend to be more effective. This is a crucial method to balance the magnitude and pace of coordinated decision-making. For successful outcomes, it's necessary to establish a flexible dual-handling organizational model for digital transformation, which can optimally balance segregation and integration over time (Smith & Beretta, 2021). There's a consensus that the main challenge faced by higher education institutions in adapting to digital transformation lies in adjusting to new teaching

methodologies and learning environments and models. Therefore, resistance to embracing digital transformation can pose a significant hurdle. Academic professions are often considered among the most stable jobs globally. If change poses a threat to job security, it's likely to be met with opposition (Rodríguez-Abitia & Bribiesca-Correa, 2021); therefore, it is crucial to establish guidelines for educational professionals to enlighten them about the benefits of technology and alleviate their concerns about job security (Alenezi, 2021). The primary obstacle to successfully integrating digital technologies into the higher education system is the generational divide between students, who are inherently familiar with these technologies, and the faculty, who must adjust and learn to use them. Therefore, due to these generational differences between students and faculty adopting technology, it is essential to advocate for policies that facilitate both the infrastructure and innovative learning environments to keep up with evolving scholarly trends. Moreover, significant emphasis will need to be placed on faculty training (Alenezi, 2021). Finally, it is observed that higher education institutions often make mistakes in determining the business case and return on investment (ROI) for their investments. Business cases for fundamental digital skills should consider actions that evolve slowly or are challenging to quantify. These may include saving faculty time and costs through more efficient operations and automation, as well as improved enrollment, retention, and timely graduation rates resulting from an enhanced student experience (Alenezi, 2021).

Notwithstanding these challenges, with appropriate tools and creativity, challenges can be transformed into opportunities. Artificial intelligence (AI) may help in the endeavor, since encompass forecasting learning progress, performance, satisfaction, suggesting resources, automated evaluation, and enhancing the learning experience. Moreover, AI-enabled suggestions of high quality tailored to student attributes, enhancement of students' academic achievements, and increased online engagement and participation (Ouyang et al., 2022).

3 Artificial Intelligence

John McCarthy was the first to define artificial intelligence in a two-month workshop at Dartmouth College in the US, even though several definitions have surfaced in recent years. Artificial intelligence (AI) is a branch of study that focuses on artificially imitating human intelligence's cognitive capacities to build computer programs or other devices that can carry out tasks that are traditionally handled by people. According to Norvig and Russell (2013, p. 24), the phrase "artificial intelligence" is used "when a machine mimics the cognitive functions that humans associate with other human minds, such as learning and problem-solving." McCarthy used the phrase "artificial intelligence" for the first time in 1956 in the workshop proposal (Russel & Norvig, 2010). They explicitly state that AI is the science and engineering of creating intelligent machines, particularly intelligent computer programs, in their definition of the term. While it is related to the related job of utilizing

computers to study human intelligence, AI need not be constrained to techniques that can be observed biologically.

AI will function under the presumption that, in theory, every facet of learning or any other characteristic of intelligence can be sufficiently correctly characterized for a machine to replicate. There will be an effort to figure out how to make machines understand language, create abstractions and notions, solve human-only problems, and advance (Zawacki-Richter et al., 2019).

Computers that do cognitive activities, generally similar to those performed by the human mind, especially learning and problem-solving, are how Aldredge et al. (2021) define AI. Additionally, they clarify that AI does not refer to a specific technology. It serves as a catch-all phrase for a variety of technologies and approaches, including genetic algorithms, machine learning, natural language processing, data mining, and neural networks.

Another way to define AI is as a group of models, techniques, and technologies (such as knowledge searching, reasoning, and representation, decision mechanisms, perception, and planning, as well as natural language processing, uncertainty handling, and machine learning) that, either individually or collectively, can resolve issues involving logical reasoning (Woods et al., 2022). As a result, the term “artificial intelligence” (AI) has a wide meaning that includes several capabilities, including knowledge, reasoning, problem-solving, perception, learning, planning, and the ability to handle and move objects (Zawacki-Richter et al., 2019). The presence of AI in various situations, including the educational context – which has progressively integrated technology instruments into the pedagogical process – is considered in this scenario.

Learning has changed as a result of the behavioral shifts that have occurred in younger generations. To prepare future professionals for both the labor market and professional vocations, teaching approaches are being changed to keep up with the technological advancements in education (Bucea-Manea-oniș et al., 2021). The ability of machines, i.e., computers, to accomplish goals through learning based on prior experiences linked with people has been termed as AI in this situation. AI is a system’s capacity to use input data to learn in order to accomplish a specific goal. Its acceptance extends beyond the field of computer science and touches on fields like information science, psychology, linguistics, and mathematics, among others. To create integrative and adaptable settings that enhance and supplement conventional educational approaches, artificial intelligence (AI) integrates techniques and findings from various scientific disciplines (Bucea-Manea-oniș et al., 2021).

In this context, artificial intelligence (AI) can be applied in higher education for individualized learning through the automation of administrative teaching tasks, software that supports the detection of topics that need reinforcement in the classroom, the guidance and support of students outside of the classroom, and the intelligent use of data to teach and support students. AI can be used in education in a variety of ways beyond than personalized instruction, including robotics, augmented reality, adaptive platforms, intelligent tutoring systems, chatbots, adaptive learning, computer aided instruction, direct feedback, and MOOCs (Kuleto et al., 2022).

In the context of education, research demonstrates that online courses, MOOCs, augmented and virtual reality, game-based learning, and collaborative work are all quantitatively linked to student learning results. Thus, Augmented Reality (AR), a technological advancement in education that has the capacity to draw students' attention to an engaging and enjoyable learning environment, can be used to demonstrate the relevance of AI to higher education (Ngabo et al., 2021). Therefore, studies on the use of AI in higher education focus on management systems and student learning opportunities. Machine learning (ML) techniques are used in conjunction with natural language processing (NLP) to identify patterns in huge datasets (human-written sources). By looking up posts on social networks, it can be used to analyze how buyers feel about specific goods or services (Aldredge et al., 2021).

Intelligent tutoring systems are a component of the AI story that enables the personalization of education by encouraging interactive learning through the creation of tutoring programs (Wang et al., 2021). These are a few of the cutting-edge technical options for expanding inclusive educational learning. While distributed intelligent teaching systems promote student collaboration through software programs that support and encourage interactions, intelligent tutors act as a guide for student learning, detecting student progress in learning based on content knowledge and the student's personal characteristics (Bucea-Manea-oniș et al., 2022).

Chatbots are a different AI-related technology that is used in higher education. In order to engage students individually, collect candidate data, and construct virtual teaching assistants utilizing this data, higher education institutions have developed chatbots (Kuleto et al., 2021). A chatbot is a piece of software that mimics text- or voice-based conversations with people. It can comprehend spoken language and pick up new vocabulary through usage. Watson Assistant (IBM), Siri (Apple), Alexa (Amazon), and Google Assistant (Google) are a few instances of well-known virtual assistants.

4 Methodology

To map digital transformation and artificial intelligence in higher education, we chose to use bibliometric analysis. Considered a science, bibliometrics involves the quantitative and statistical study of the production, publication, use, and dissemination of scientific knowledge from bibliographic databases (Gutiérrez-Salcedo et al., 2018).

Through analytics and statistical tools, it allows to evaluate, verify, identify, and monitor the progress of fields of study through the classification of data such as citations and collaborations, author affiliations, keywords, topics discussed, relevant topics, and methods used (Ali et al., 2016).

The study was divided into three independent phases for the bibliometric analysis: planning, data collecting, and findings. These steps came together to respond to the study's central query: How can artificial intelligence technology be used in higher education?

Planning lasted from September through May 2023, when the research was carried out. Due to the quantity of documents deemed sufficient in the research bases in the database selected for this research, some criteria were defined in this phase as the limitation of the search in electronic databases, which in this research's case was the Web of Science (WOS). Due to the WoS database's importance in academia and its interdisciplinary nature, which is the focus of this area of research, it was specified in the planning scope as pertinent to the research domain. And also due to the fact that it is one of the largest databases of summaries and bibliographic references of peer-reviewed scientific literature and its constant updating (de Bem Machado et al., 2022). The terms used in the WOS database search were: "Digital Transformations" and "Higher Education."

Since a notion depends on the context to which it is related, it is believed that the variations of the search terms are offered, in a bigger context, inside the same proposition. Finally, it was chosen to just use the terms defined in the "title, abstract, and keyword" sections when planning the search, excluding any additional criteria that would have limited the results, such as time or language. Furthermore, documents of the "article" type were used as the inclusion criterion.

From the research planning, the data collection, carried out on 30 May 2023, retrieved a total of 13, indexed papers, which pointed registration from 2019, the first publication, until 2023.

4.1 Results of Bibliometry

As a result of this collection, it was identified that the 13 papers identified in the search were written by 41 authors, linked to 11 different countries. A total of 86 keywords were used. Table 1 shows the results of this data collection in a general bibliometric analysis.

Table 1 Bibliometric data

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2019:2023
Documents	13
DOCUMENT CONTENTS	
Author's Keywords (DE)	86
AUTHORS	
Authors	41
AUTHORS COLLABORATION	
Single-authored docs	1
Co-Authors per Doc	3,15
International co-authorships %	23,08
DOCUMENT TYPES	
Article	13