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Digital Transformation and E-Learning Integration during the Post-Pandemic Era in the Algerian Higher Education Sector

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Abstract

Over the past twenty years, major technological breakthroughs have sparked the development of new educational methodologies, notably digitalization and E-learning, which have garnered increased attention. The primary aim of this study is to explore the utilization and integration of ICT and E-learning in higher education settings. It provides a historical overview of higher education in Algeria and offers a foundational understanding of digital transformation, particularly in ICT and E-learning within higher education. To achieve this aim, an online questionnaire was conducted with a random sample comprising students and faculty members of the Computer Science Department at Laghouat University, spanning various academic levels. The study's findings underscore the efficacy of digitalization and E-learning as valuable tools in the learning process while revealing the opportunities and challenges associated with their implementation. This research seeks to raise awareness among educators and learners regarding using ICT and E-learning in education, fostering readiness for embracing digital transformation, particularly in the post-COVID-19 era where distance learning has become imperative for global wellbeing.

Keywords: Digitalization, E-learning, Higher Education, ICT, Integration, Post Pandemic

ملخص

خلال العشرين سنة الماضية، قاد التطور التكنولوجي البارز إلى ظهور منهجيات تعليمية جديدة، لا سيما الترقيم الرقمي والتعلم الإلكتروني، التي لقت اهتماما متزايدا. الهدف الرئيسي من هذا البحث هو استكشاف استخدام ودمج تكنولوجيا المعلومات والاتصالات والتعلم الإلكتروني في إعدادات التعليم العالي. يقدم هذا البحث نظرة تاريخية على التعليم العالي في الجزائر ويقدم فهما أساسيا للتحول الرقمي، خاصة في تكنولوجيا المعلومات والاتصالات والتعلم الإلكتروني في التعليم العالي . ولتحقيق ذلك الهدف، تم تنفيذ استبيان عبر الانترنت على عينة عشوائية تتألف من الطلاب وأعضاء هيئة التدريس في قسم علوم الحاسوب في جامعة الأغواط، والذين يمثلون مستويات أكاديمية متنوعة. تؤكد نتائج الدراسة فعالية الترقيم الرقمي والتعلم الإلكتروني كأدوات قيمة في عملية التعلم، مع الكشف عن الفرص والتحديات المرتبطة بتنفيذهما. يسعى هذا البحث إلى زيادة الوعي بين المعلمين والمتعلمين بشأن استخدام تكنولوجيا المعلومات والاتصالات والتعلم الإلكتروني في التعليم، وتعزيز استعدادهم لاعتناق التحول الرقمي، خاصة في العصر ما بعد جائحة كوفيد-19 حيث أصبح التعلم عن بعد ضرورة لصحة العالم بأسره.

الكلمات المفتاحية: الرقمنة، التعلم الإلكتروني، التعليم العالي، تكنولوجيا المعلومات والاتصالات، الدمج، ما بعد الجائحة

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Introduction

During the past twenty years, numerous technological innovations have emerged, streamlining various aspects of our lives including education, through computers and online technologies. The education landscape worldwide is undergoing significant changes as modern technologies transform how higher education is delivered and how students learn. Nowadays, new ways of learning and teaching have emerged globally. Digital transformation and E-learning integration are forms of education to which attention has increased. Educational technology is integrated as a supportive didactic tool in most Algerian universities. Educational technology improves learning, which supports the need to expand the use of these technologies for today's students and provide them with efficient tools for learning. In developing countries, education is becoming increasingly important because of its positive impact on the nation's economic and social standing. In this vein, Algeria has increased its focus on the information and communication technology sector, raising budgets for various related sectors to the highest levels. Believing in the university's role and its importance in achieving development and prosperity, Algeria has focused on modernizing the higher education sector, which has significantly benefited from various tools and modern technologies (Djoudi, 2010). The present research studies the current digital transformation and E-learning integration and adoption at the University. The study aims to analyze the prospects of benefiting from these technologies in Algeria to minimize the problems facing the higher education system at the University and explore new educational technologies, especially in the new era after the covid 19 coronavirus pandemic, where distance learning became an obligation to save lives all over the world. The study also identifies the challenges that hinder the growth of e-learning and assesses the readiness of computer science students to integrate e-learning into higher education.

The Algerian University is a public, non-profit higher education institution that offers courses and programs leading to accredited degrees across a variety of fields of study. The study was conducted at the Department of Computer Science.

The Algerian government has investigated a significant amount of money devoted to scientific research to provide universities with new technologies. The integration of E-learning and digitalization may be considered an essential factor when attempting to enhance the learning process of future educators. Attitudes and perceptions towards technology integration affect the extent to which technology is used. This study tried to explore how education in Algeria is digitalized and improved with ICT and E-learning as perceived by teachers and students. We will also seek to understand students' perceptions of potential improvements to the educational technology system in Algeria, to identify the possible benefits of using ICT and E-learning.

The purpose of the study is to examine the status of digitalization, e-learning, and ICT in Algerian higher education, and to identify the opportunities these technologies present as well as the barriers to using ICT in higher education. In addition, the study will investigate the different views expressed by teachers and learners in the Computer Science Department at the university. This research is intended to explore the following:

- Examine the digital transformation and the use of ICT and E-learning in higher education

- Explore the benefits and the barriers of the integration of ICT and e-learning

- Investigate the views expressed by teachers and learners of the Computer Science Department at the University about digitalization.

- Making teachers and learners aware of the importance of including ICT and E-learning in their teaching-learning process.

This study is significant for expanding the potential for developing digitalization, ICT, and e-learning in Algeria. The problem is important because there is a lack of technology use in

Algerian universities, which prevents students from receiving its benefits. Technology is essential to provide today's learners with optimal opportunities. Thus, the findings of this study will provide information on overcoming the problems by revealing the reasons behind the non-use of technology. Study results are essential for designing and integrating e-learning into higher education. Findings will also help guide future research.

The focus of integrating new technologies into the teaching and learning process is to enhance its efficiency and productivity. However, traditional learning methods must adapt to these new tools to keep pace with globalization and advancements in technology. The role of digitalization and E-learning in higher education is essential.

The main research question of this study is how digital transformation and e-learning are utilized and integrated into higher education. To address this question, the study explores the following specific inquiries.

1. What is the current status of digital transformation and the use of e-learning in the higher education system at the university?
2. What are the benefits of integrating e-learning, and what constraints hinder its integration into higher education?
3. How do teachers and students perceive and adapt to the new ICT and e-learning platforms?

To help find answers to the previous set of research questions mentioned above, we formulated three hypotheses.

1. The current status of integrating digitalization and using ICT and e-learning in higher education, specifically in the Computer Science department at the university, might be advanced.

2. The Opportunities and the challenges of educational technology that might be found in the department.

3. Whether Teachers and students accept the new digitalization/E-learning platforms or not.

In an attempt to tackle the research problem, a case study is implemented along with one research instrument, namely, an online questionnaire with Computer Science students and teachers at the University, who are selected based on their experience with technology in teaching and learning to elicit a quantitative data that might result in satisfactory answers for the research problematic. The current study embodies four sections. The first section of the literature review is theoretical, providing an overview of the history of higher education in Algeria and a basic explanation of digitalization, ICT, and e-learning. Furthermore, the second part provides a general background on the use and integration of digitalization and e-learning in higher education, as well as the main challenges and opportunities associated with educational technology. Accordingly, the second section offers a brief description of the research design and methodology used, including the random sampling procedures and instrumentation. The third section addresses the practical aspect of the research, where the collected data is analyzed and interpreted using a quantitative approach. Hence, it discusses the results obtained from both questionnaires. Finally, the last section explores the research limitations, the findings, and the future directions.

Literature Review

In the twenty-first century, the environment surrounding higher education has been dramatically changing due to globalization, as well as rapid technological advancements; as, Gupta points out, "We have moved from the industrial age to the networked age. We have moved from the agricultural and industrial revolutions to the information revolution" (Bhatia, 2011). In particular, progress in Information and Communications Technology (ICT) has released space and temporal constraints from the traditional higher education system, providing the foundation for bringing a new kind of higher education based on digital transformation. Universities are compelled to adapt to emerging developments in ICT. The introduction of e-learning systems is a new trend aimed at providing students with online access to learning

content (Qureshi et al., 2012). The first part of this section will focus on the theoretical background of higher education in Algeria and the new trends in technology, namely digitalization, ICT, and e-learning.

History of Algerian Higher Education

Algeria is currently undergoing a transitional phase that presents significant challenges in political, economic, cultural, scientific, and technological fields. The university plays a key role in this transition. Gheraf (2014) pointed out that, since independence, the Algerian university went through five stages:

ϖ From 1962 to 1971: The number of students from 1962 to 1971 was very small, and the only university at the national level was the University of Algiers.

ϖ From 1971 to 1984, following the establishment of the University of Science and Technology (USTHB) and the University of Oran, the number of students increased rapidly. However, by the early 1980s, the situation worsened due to the economic crisis. Universities struggled with inadequate infrastructure, equipment, classrooms, and laboratories.

ϖ From 1984 to 1999, the number of students, both male and female, continued to rise, leading to widespread overcrowding in Algerian universities. This situation resulted in the establishment of a network of university centers across the country.

ϖ From 1999 to 2002: The increasing number of students in all disciplines, even if it is a positive criterion in the growth equation, remains the central dilemma of supervising.

Moreover, many professors had left the country since the early 1990s. For example, the University of Algiers alone has lost 108 professors enrolled in foreign universities in the West and the Arab world.

ϖ From 2002 to this day, there has been the involvement of a uniform study structure known as LMD (Licence-Master-Doctorate). This came into effect from 2004-2005, designed to align Algerian higher education with international systems and standards.

What is noticeable in this last period is the persistent attempts to introduce the technological element in all administrative work of higher education (Hamouche, 2007).

Educational Imbalances in the Algerian University

Despite the positive results achieved by Algerian Higher Education over the past decades, it remains far from the desired level in terms of quality. Today, it suffers from a set of imbalances and deficiencies at various levels, including the growing number of students, challenges in supervision, a lack of pedagogical facilities, brain drain, and the tendency of professors to leave for more attractive opportunities elsewhere. As a result, Algeria is facing an increasing gap that separates it from the developed world. In this context, the Algerian university is seeking the most effective ways to use modern technologies in research development, education, and the improvement of administrative management in educational institutions. Furthermore, it has become a critical element of the globalization of thought and knowledge. Despite the problems we have pointed out, the Algerian University remains a source of pride for its achievements since independence in 1962. It started from the ground up, introducing a culture of learning and training for all Algerian citizens through tuition-free education. The Ministry of Higher Education and Scientific Research developed a strategy to advance Algeria's educational system in line with the latest international standards, with a particular emphasis on incorporating the most up-to-date ICT resources into the educational sector.

Digitalization

Digital transformation in higher education involves integrating and using digital technologies to improve and transform various aspects of the educational process within institutions. This encompasses various digital tools, platforms, and methodologies that aim to improve teaching, learning, administration, and overall educational experiences.

Critical components of digitalization in higher education include Technology Integration, Online Learning (E-learning), Digital Resources, Learning Management Systems, Collaborative Tools, Administrative Efficiency, Virtual Reality (VR), and Augmented Reality (AR).

Digitalization in higher education aims to meet the evolving needs of students and prepare them for the demands of the modern workforce by creating a dynamic and technology-driven learning environment. It also contributes to the efficiency of administrative processes, allowing institutions to manage resources better and enhance overall effectiveness.

Information and Communication Technology

Several definitions have been given to explain and interpret the acronym ICT. It stands for ICT. Generally, this term refers to a broad array of components related to computing and digital technologies (Christensson, 2008).

Conner and Sliwka (2014) describe ICT as an expanded form of IT, encompassing 'any device or system that enables the storage, retrieval, manipulation, transmission, and receipt of digital data.' They further assert that this data must be digital or electronic and involve collaboration and communication. The range of ICT types is extensive, but it continues to expand. According to Turner, the main kinds of ICT are three hardware, software communications technology:

- ICT software includes standard office applications, database software, graphics software, web design software, programming languages, and more.
- ICT software includes Standard Office Applications, Database software, Graphics, web design software, programming languages software, etc.
- 'C' in ICT stands for communications technology and covers all the communications technologies such as digital TV, digital radio, e-mail, Internet, networks (wired and wireless), mobile phones, videoconferencing, instant messaging, etc.

E-learning

E-learning is one of the most popular and widely used educational systems due to its flexibility, benefits, and support for the mental development of learners. E-learning, or electronic learning, has been defined in many ways in the literature. It is essential to note that there is no universally accepted definition of e-learning. According to the Oxford Dictionary, e-learning is described as "learning conducted via electronic media." In the field of learning and education, e-learning includes new technologies such as computers, digital technology, networked digital devices, and related software (Jaggi, 2015). In this context, e-learning is learning with the aid of ICT technology. Similarly, Challis et al. (2003) consider that E-learning entails the primary utilization of Information and Communication Technology (ICT) within educational settings to facilitate teaching and learning processes.

The realm of E-learning has developed over the years at a fast pace. These technological developments resulted in the classification of E-learning. In this vein, E-learning can be categorized into three categories (Kwofi, 2015):

Category 1: Internet and web-enabled: E-learning is used to offer online learning services, which can be provided using different approaches: - Blended/hybrid, where the physical

presence of students and teachers on campus is combined with content and instruction via digital and online media (Kim 2007).

In a fully online format, content and instruction are delivered through digital and online media, allowing learners to access materials at any time and from any place, regardless of the availability of teachers. For each of these two approaches, the learning process can occur in either 'real-time' mode (synchronous) or 'non-real-time' mode (asynchronous).

Category 2: Radio, TV, CD/DVD—this category is used to deliver one-way learning services involving listening to or watching instructional materials on a CD/DVD using a computer, with no means of communication.

Category 3: Satellite technology is used to deliver instructions via videoconference, allowing participants to communicate through satellite media. The next section will focus on the utilization of ICT and e-learning in higher education, discussing the various opportunities and challenges associated with adopting these technologies, as identified by numerous researchers in the literature.

Adoption of digital transformation and Integration of ICTs and E-learning in the University Environment

It has widely been recognized that in higher education, ICTs hold the potential to transform learning in new and powerful ways. According to Watson (2001), "ICT is perceived as a catalyst for change, change in teaching style, change in learning approaches, and change in access to information" (p.251). For instance, the Internet and the World Wide Web have transformed the learning process, bringing dramatic changes to various aspects of education, including distance and online learning, collaboration, and virtual classrooms (Wong, 2010). In this vein, the Algerian Universities have managed to implement the digitalization platform. They possess the basic ICT infrastructure such as Local Area Network (LAN), Internet, computers, CDs, and DVD facilities that form the basis for establishing an E-learning platform using Moodle software. Although E-learning seems to be a promising opportunity for educational systems, its integration is still facing many challenges.

Benefits, Advantages of Integrating Digitalization and E-learning in Higher Education

The adoption of digitalization and e-learning in higher education offers several benefits, making e-learning one of the most effective methods of education. Based on the literature review, we conducted a comparative study of previous research on the benefits and advantages of digitalizing learning, comparative study of digitalization and e-learning advantages and benefits is provided in Appendix A Table 1.

Although new technological trends in education offer various opportunities, they have not been effectively integrated into the learning process. Teaching still relies on a single approach, lacking multiple methods to develop a culture of digitalization in education (Bhuasiri et al., 2012).

Barriers to the Integration of Digitalization and E-learning in Higher Education

Literature highlights several challenges related to integrating digitalization and e-learning into higher education. Accordingly, we conducted a comparative study, examining various previous works on the challenges associated with the implementation of digitalization and e-learning in higher education. For a complete breakdown of the results, see Table 2 in Appendix B.

E-learning in Algeria Before, During, and After COVID-19

E-learning in Algeria Before COVID-19

Before the onset of the COVID-19 pandemic, e-learning in Algeria was in its infancy. The adoption of Information and Communication Technology (ICT) in education faced

significant challenges. Most educational institutions in Algeria relied heavily on traditional face-to-face teaching methods, with only a few universities experimenting with blended learning models.

Studies from this period, such as the one by Djoudi (2018), highlighted the slow integration of e-learning technologies due to systemic barriers, such as inadequate resources. Another study by El Kechebur (2017) pointed out that e-learning initiatives were largely limited to isolated projects, often driven by individual faculty members rather than being part of a cohesive national strategy.

E-learning During COVID-19

The COVID-19 pandemic acted as a catalyst for the rapid adoption of e-learning in Algeria. With the closure of educational institutions in early 2020, there was an urgent need to transition to online learning to ensure continuity of education. This shift was marked by the widespread use of digital platforms, video conferencing tools, and online resources.

Research conducted during the pandemic, such as the study by Arabeche and Soudani (2021), documented the challenges and opportunities presented by this sudden shift. The study found that while many institutions managed to implement e-learning solutions quickly, the transition was far from smooth. However, the pandemic also brought to light the potential of e-learning to reach a broader audience, particularly in remote and underserved areas.

A survey conducted by Yahiaoui et al. (2022) indicated that despite these challenges, there was a growing acceptance of e-learning among teachers and students.

E-learning in Post-COVID-19

In the post-COVID era, e-learning has become an integral part of the educational landscape in Algeria. The experiences and lessons learned during the pandemic have informed the development of more robust e-learning systems. Many educational institutions have adopted hybrid models, combining online and in-person learning to offer greater flexibility and accommodate diverse learning needs.

Recent studies, such as the one by Boudia and Bengueddach (2023), have explored the long-term impact of the pandemic on e-learning practices in Algeria. The research found that while significant progress has been made in integrating e-learning into the education system, challenges such as inadequate infrastructure, and resistance to change persist. The study also highlighted the importance of government support and investment in ICT to sustain the momentum gained during the pandemic.

Another study by Abdaoui and El Aggoune (2024) examined the effectiveness of online learning through Google Meet for Moodle in Algerian universities. The findings suggested that while new learning models have been well-received, there is a need for ongoing professional development for teachers to enhance their digital competencies and adapt to new teaching methods.

Transformation Across Stages

The transformation of e-learning in Algeria can be seen as a three-phase process.

- Pre-COVID-19: E-learning was in its early stages, with limited adoption and significant barriers to implementation.
- During COVID-19: The pandemic forced a rapid and widespread adoption of e-learning, revealing both the potential and the challenges of online education.

- Post-COVID-19: E-learning has become more established, with hybrid models emerging as a common approach. However, there is still a need for improved infrastructure, digital literacy, and institutional support to fully realize the potential of e-learning in Algeria.

Despite the progress made in e-learning during and after the COVID-19 pandemic, there remains a significant research gap in the Algerian context. There is a need for more research on the specific challenges faced by different regions in Algeria. The digital divide, particularly in southern areas, such as Laghouat, is a critical issue that requires further investigation. Addressing this gap will be crucial for developing a more inclusive and effective e-learning ecosystem in Algeria.

The previous subsections covered the theoretical background of higher education in Algeria, including the use of digitalization and e-learning, as well as the various opportunities and challenges associated with adopting these technologies. Moreover, the literature review highlighted the stages of E-learning in Algeria, before, during, and after COVID-19, and how the transformation takes place through the different stages. In this subsection, we will elaborate on the methodology of the research.

Methods and Materials

Every research project has specific objectives; in this particular study, we have designed three objectives, which are the following:

1. To shed light on the use of technology in higher education.

2. To investigate the opportunities and challenges of educational technology in higher education.

3. To examine the acceptance of digitalization in the Computer Science department.

Participants

A sampling is selecting a group of subjects meeting a designated set of criteria. Our study focused on LMD students and teachers of Computer Science at Laghouat University, one of the Algerian universities. We randomly selected a sample consisting of 34 students. Our rationale for choosing this population category is attributed to the fact that the number of LMD computer science students is huge to conduct research on as a population. The latter consists of 340 students. On the other hand, we contacted all 35 teachers in the Computer Science department.

Table 3. *The distribution of questions in the questionnaire*

Sections	Type of questions	Number of questions
Section one	Background information	3Q (students)
		4 Q (teachers)
Section two	The use of ICT and Digitalization in education	15Q (students)
		17Q (teachers)
Section three	The probable obstacles while using ICT and digital transformation	16Q (students
		18Q(teachers)

Research Instruments

To collect data on the perceptions and adaptation of teachers and students to new ICT and e-learning platforms, a quantitative instrument was employed, utilizing an online questionnaire, developed to quantify the attitudes, perceptions, and experiences of both teachers and students regarding ICT and e-learning platforms. The questionnaire consisted of multiple sections, including background information, the use of ICT and Digitalization in education, and

the probable obstacles while using ICT and digital transformation.

Research Procedures

The research was conducted in several phases to ensure comprehensive data collection and analysis. The first phase is instrument development, where the questionnaire was developed based on a review of relevant literature and consultation with experts in the field of educational technology. The second phase is data collection, here the finalized questionnaire was distributed electronically (online) to teachers and students across the selected department. Responses were collected over two weeks. Finally, the third phase encompasses the questionnaire data, which were analyzed using statistical software to generate descriptive statistics to identify key factors influencing the acceptance of ICT and e-learning platforms.

Results

This section is dedicated to presenting, analyzing, and interpreting the collected data.

Computer Science Students' Questionnaire

This questionnaire aims to collect the data needed to answer our research questions. We have selected the most important questions to achieve this goal.

The use of ICT and Digital Technology in education:

Question 1: How often do you access the internet from your department?

This question is designed to determine the frequency of internet access in the Computer Science department.

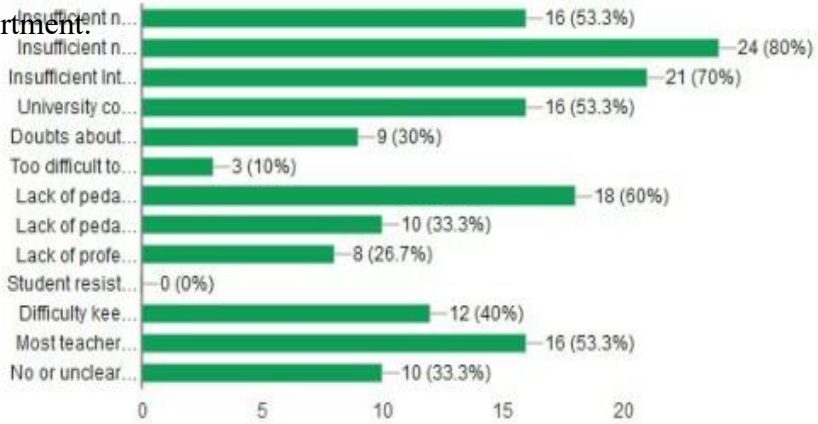

Figure 1. The frequency of accessing the internet from the department

The findings of this question reveal that the majority of the students cannot access the internet from the department by 61.8%. In contrast, 20.6% responded that they could access the internet only from the computer found in the classes. However, 14.7% of the students reported that they accessed the internet once a week or more. The rest claimed that they could access the internet every day by 2.1%.

Question 2: In terms of method of teaching preference, what do you like? This question seeks to reveal the preferred teaching method for computer science students.

Accordingly, 78.8% of the students preferred e-learning using digital platforms, while 21.2% favored traditional methods.

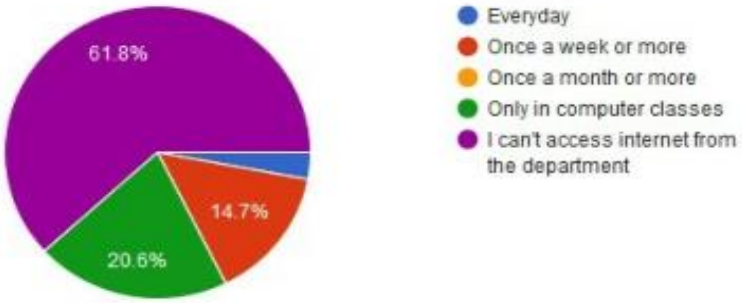

Figure 2. Traditional learning vs. e-learning

Obstacles to using ICT and digital platforms in teaching and learning

Question 1: Obstacles to using ICT and digital platforms in teaching and learning: Is your university affected by a shortage or inadequacy in the following areas? This question is composed to obtain the main obstacles students face while using ICT in teaching and learning.

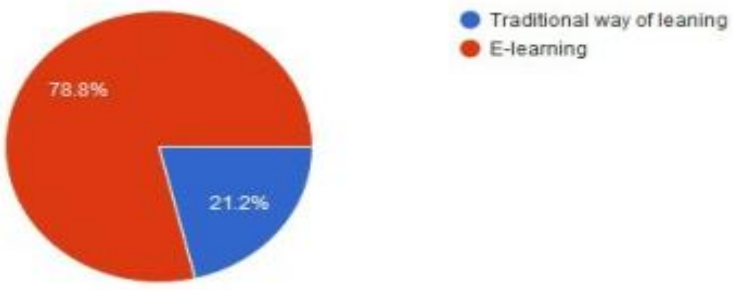

Figure 3. Obstacles to using digitalization in teaching and learning

The following table introduces the obstacles to using digitalization in the teaching-learning process.

Table 4. *Obstacles to using digitalization in teaching and learning*

Obstacles	Insufficient number of computers	Inadequate number of Internet-connected computers	Insufficient Internet bandwidth or speed	University computers are out of date and, or need repair	Doubts about technology's usefulness in teaching your courses	Too tricky to integrate ICT use into the curriculum
%	53.3%	80%	70%	53.3%	30%	10%
Obstacles	Lack of pedagogical models on how to use E-learning platforms	Student resistance to technology	Difficulty keeping up with changes in technology	Most teachers are not in favor of ICT use in the university setting	There is no clear benefit or an ambiguous benefit to	

					utilizing ICT and E-learning in teaching	
%	60%	0%	40%	53%	33.3%	

The results in the above table indicate that 80% of students reported having an insufficient number of internet-connected computers, and 70% stated that they experienced inadequate internet speed. Additionally, 53% of the students mentioned that the number of computers is insufficient and that there is a lack of pedagogical models for using digital platforms. Despite these issues, the table shows that students exhibit no resistance to technology.

Computer Science Teachers' Questionnaire

The objective is to quantify the teachers' responses and present them as statistical data, summarized in figures and tables. We have selected the most important questions for this purpose.

The use of ICT and digital Technology in education

Question 1: Do you think computer technology would help you teach efficiently?

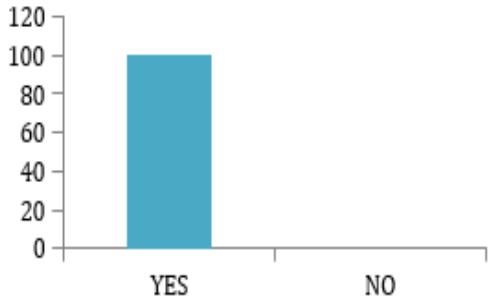

Figure 4. The role of computer technology in making teaching efficient

Teachers were asked about the role of computer technology and whether it helps in making teaching efficient or not. 100% of the responses stated that they have benefited from computer technology in teaching. This shows that ICTs are essential tools that have helped teachers teach more effectively.

This question was formed to examine whether teachers participated in an e-learning program or not. 53.3% of respondents approved that they have participated in a digitalized E-learning program. The other teachers requested that they not participate yet.

Question 2: Will you accept the new E-learning and digital platforms at your department in the future?

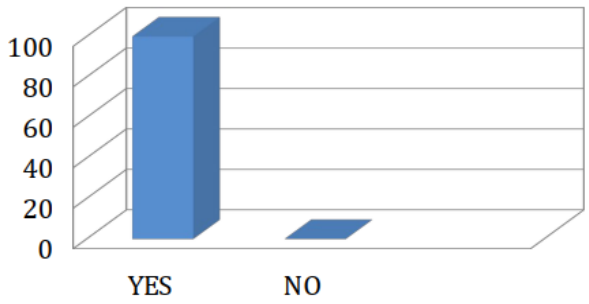

Figure 5. The acceptance of the new e-learning

This question is designed to assess teachers' acceptance of the new digitalized e-learning platforms. The results indicate that all participants have accepted the new e-learning platforms.

Obstacles to Using ICT and Digital Platforms for Instruction and Education

Question 1: Challenges hindering the adoption of ICT in teaching and learning: is your university affected by a shortage or inadequacy in the following areas?

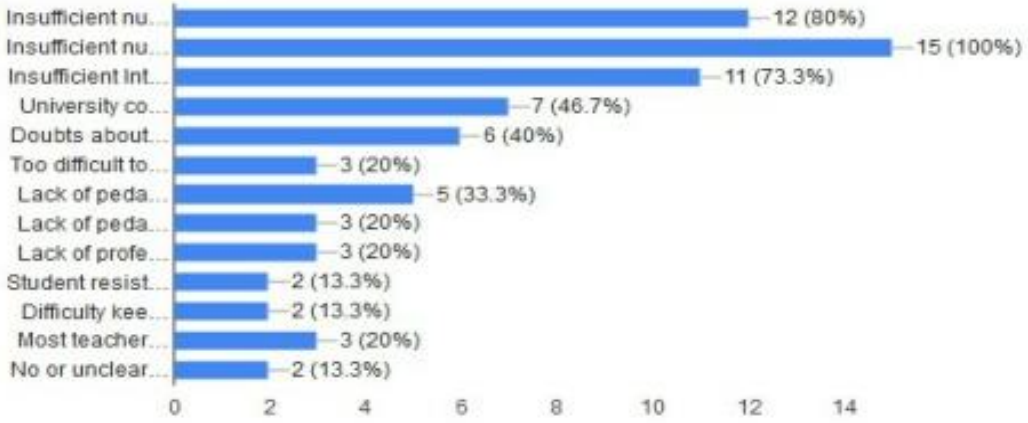

Figure 6. Obstacles to using digitalization in teaching and learning

The outcomes in the bar chart above indicate that 100% of the teachers reported having an insufficient number of Internet-connected computers, and 80% of them stated that they experience inadequate Internet speed and a shortage of computers. Moreover, around 40% of the teachers said that the university computers need repair and that there are doubts about technology's usefulness in teaching courses. The minimum percentage of 13% represents the teachers' difficulty in keeping up with technological changes and the unclear benefits of using digital platforms and e-learning in teaching.

Discussion

The use of e-learning in universities is growing, with many institutions adopting online platforms like Moodle. However, progress varies, with challenges like unequal digital infrastructure and limited faculty training hindering full integration. The benefits of integrating E-learning rely on offering flexibility, personalized learning, cost efficiency, and global collaboration. In contrast, the barriers include a lack of teacher training, resistance to change, and infrastructure limitations. Concerning the teachers' and students' perceptions and adaptation to ICT and e-learning, teachers appreciate flexibility but face challenges adapting to online teaching and technical aspects. Whereas students value flexibility but struggle with isolation, technical issues, and maintaining motivation.

The purpose of the Students' Questionnaire was to measure students' opinions and perceptions regarding the use, role, and importance of digitalization, ICT, and e-learning. The data gathered from this questionnaire reveals that most computer science students use ICT and E-learning.

Throughout the observation of the results of the first question, most students cannot access the Internet from the Department of Computer Science. In contrast, others can only access it from computers available in the classrooms. Moreover, the data collected from the second question show a wide acceptance among students of the new digitalized e-learning

platforms. Computer science students prefer E-learning over traditional learning. This is consistent with findings from previous studies by Holmes and Gardner (2006), Almarabeh (2014), Qureshi (2012), and Bhatia (2011). However, in line with the ideas of Bhuasiri et al. (2011), it can be concluded that e-learning needs to be effectively integrated into the learning process, as it is still in the early stages of adoption in developing countries. It is clear that students also face problems when using ICT in the teaching and learning process. The question revealed that Computer Science students face technical problems and have an insufficient number of internet-connected computers. Nearly half of the students relate the difficulty due to the absence of educational frameworks for the effective utilization of ICT in the learning process at Laghouat University, which is situated in the south of Algeria. A similar pattern of results was obtained in Aung and Khaing (2015), Sife et al. (2007), Al-adwan and Smedley (2012), Alturise and Alojaiman (2013), Boudia and Bengueddach (2023). Contrary to the findings of Kenan, Pislaru, and Elzawi (2012), Alturise and Alojaiman (2013), and Djoudi (2018), we did not find any resistance to technology among students. Our findings denote more acceptance of using ICT and integrating technology from students of the South in the new post-COVID era.

The Teachers' Questionnaire aimed to explore teachers' beliefs, attitudes, willingness, and concerns regarding computers in general and the use of digital technologies in teaching specifically.

The results from the first question indicate a unanimous agreement that the Internet enhances teaching efficiency. In contrast, the results of the second question show that computer science teachers fully accept the adoption of new e-learning platforms in the future. This conclusion aligns with findings from Holmes and Gardner (2006), Unwin (2008), Qureshi (2012), Bhuasiri et al. (2011), and Yahiaoui et al. (2022).

The second section of this questionnaire represents the actual status of using digitalization at Laghouat University. There is a high use of ICT but a low use of e-learning among students and teachers. As stated in the first hypothesis, the use of ICT might be high.

For the last section, the question aims to list the everyday obstacles to using ICT and digital platforms among teachers. The bar chart indicates that most teachers suffer from an insufficient number of computers, insufficient Internet-connected computers, and insufficient Internet speed. Moreover, the next three bars, ranging from 46.7% to 33.3%, indicate that teachers attribute the difficulties to another technical issue: the need for repairs on university computers. These results extend beyond previous studies, such as those by Sife et al. (2007), Alturise and Alojaiman (2013), and Boudia and Bengueddach (2023), showing that the lack of access to resources such as computers and the Internet is a complex issue that discourages teachers from integrating new technologies into university classes. In addition to personal barriers, such as doubts about the usefulness of digital technology in teaching, many teachers are not in favor of using ICT in university courses at Laghouat University.

Furthermore, other problems appeared on the pedagogical and the curriculum sides, which took 20% for each. However, in line with the ideas of Al-Adwan and Smedley (2012), it can be concluded that the lack of qualified staff significantly hinders the effectiveness of the E-learning process. The most minor percentage, 13%, represents teachers' difficulty in keeping up with changes in digital technology and understanding the benefits of using E-learning in teaching. These primary findings are consistent with the research of Kenan et al. (2012), Alturise and Alojaiman (2013), and Arabeche and Soudani (2021). Thus, from our findings, we conclude that there are still several barriers to using ICT and digital platforms in teaching and learning in the post-pandemic era at Laghouat, contrary to more developed areas. These difficulties are categorized into three types: technical, pedagogical, and personal obstacles.

Research Limitation, Findings, and Future Directions

The research was conducted at Laghouat University in the Department of Computer Science to explore the digital divide in Southern areas during the post-pandemic era. We opted to include students and faculty members from different levels in our population. A questionnaire was administered to the study participants, including students and faculty members. Consequently, we have opted to distribute online questionnaires through the net. Therefore, while 100% of the student questionnaires were returned, only 42% of the teachers responded from the total examined population. This represents the main limitation of the study.

The findings revealed that computer science learners and teachers are inclined to integrate digital technology and e-learning into their learning process. The vast majority of learners and teachers strongly agree with the importance of using ICTs as tools for learning. The data analysis yields the following findings: First, technology use in teaching and learning is widespread, and the importance of digitalization, ICT, and E-learning is increasing during the post-pandemic era. Traditional learning methods are being complemented by E-learning. Furthermore, to use digitalization and ICT and to incorporate E-learning, there must be support from the pedagogical models. Finally, to successfully integrate new digital technologies, there must be cooperation among teachers, learners, and the pedagogical framework.

As future directions, we recommend encouraging teachers to be mentors, tutors, and guides of the student's learning process to promote cooperative and collaborative learning guide on the side and establish partnerships and collaboration between the Algerian University and other universities of the developed world to bridge the gap of the digital divide. Besides, the training for teachers of the Algerian University will help them build their knowledge and skills in digital learning environments. Moreover, the university should be provided with additional computers connected to the internet and equipped with high bandwidth. Finally, it is high time to integrate MooC courses in learning as a supplement to Moodle to benefit from its beautiful opportunities and explore new educational technologies, especially during the new era of the post-COVID-19 coronavirus pandemic. This subsequent period following the pandemic, characterized by the proliferation of distance learning became an obligation to save lives all over the world.

Conclusion

This study was conducted to provide teachers and learners with a comprehensive overview of the significance of digital transformation, ICT, and E-learning in the context of the learning process during the post-pandemic era. This research aims to examine digital transformation and the incorporation of ICT and E-learning into the Algerian higher education sector, exploring the digital divide in the Southern areas, the case of Laghouat University.

To conclude, this research suggests that the implementation of digitalization and E-learning significantly improves the performance of both students and teachers. Therefore, these findings go hand in hand with the main hypotheses put forward to the study. The research findings reveal that ICT and E-learning are valuable resources for education. They also highlight the opportunities and challenges associated with their use and integration into the educational process. This research helps teachers and learners become more aware of using ICT and E-learning in education. It prepares them for adopting new digital technologies and equips them to face the challenges of teaching and learning in both the pandemic and post-pandemic eras.

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Declaration of AI Refined

This research paper has undergone language correction using the AI-powered tools Grammarly and Scholar AI Chat to address grammatical, spelling, and stylistic errors. It is acknowledged that the use of such tools may introduce standardised patterns typical of AI-generated content. Consequently, a certain percentage of content may reflect AI-generated language structures. Yet, the intellectual content and the analysis remain entirely the work of the authors.

Statement of Absence of Conflict of Interest

The authors mentioned above hereby solemnly declare that they are not and shall not be in any situation that could give rise to a conflict of interest in what concerns the findings and recommendations contained in this academic article.

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Appendices

Appendix A

Table 1. *Comparative study of digitalization and e-learning advantages and benefits*

Works Advantages	Holme and Gardner	Almarabeh	Uys	Unwin	Qureshi	Bhatia	Bhuasiri et al.
Flexibility	*	*	*	*	*	*	*
Efficacy	*			*	*		*
Scalability				*			
Interactivity	*			*	*	*	*
Connectivity						*	
Cost Efficiency	*	*	*	*	*		
Individual Differences	*						
Self-pacing	*	*		*			*
Availability				*			*
Student-centered E-learning				*			
Learning/training opportunities				*			
Freedom of speech				*			
Virtual Learning Environment						*	
Personalized instruction							*
Content standardization							*

Appendix B

Table 2. *Comparative study about the challenges of integrating digitalization and e-learning*

Works Challenges	Aung and Khaing	Al-adwan and Smedley	Orr and Heaton	Kenan, Pislaru and Elzawi	Nyandara	Sife, et al.	Alturise and Alojaiman
ICT	*	*			*	*	*
Contextual Factors	*					*	

Teachers' Competencies	*					*	*
Technical Difficulties	*	*	*		*	*	*
IT Literacy	*	*		*	*		*
Language Competency	*	*		*			*
Awareness	*					*	
E-Readiness	*						
Lack of Training	*	*		*			*
Lack of Interests		*		*			
Rigid Learner-Teacher Relation				*			
Load on the Academic Staff		*		*			*
Lack of Official Recognition				*			
Insufficient Qualified Staff		*				*	*
Lack of Access to Resources						*	*
Resistance to Change				*			*
Lack of Income							*
Lack of Face-to-Face Contact		*					

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