Emerging Technologies and Their Acceptance in Higher Education

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Emerging technologies (ETs) are characterized as innovative technologies that provide an improvement over other traditional technologies in a specific area. These technologies are not at an adequate level of maturity, because they are still under development.

emerging technologies   intelligent education   personalized education   active education

1. Introduction

In recent years, learning has become increasingly open, collaborative, informal, flexible, blended, massive, and portable [1]. These characteristics allowed for ubiquitous access to educational resources during the mandatory lockdown due to the pandemic caused by COVID-19, which was of great help to educational institutions, teachers, and students [2]. In this context, digital technologies play a very important role so that the educational system does not stop, and students can continue with an online and distance learning curriculum [3]. These technologies proved to have ample potential for use as a support in education, but being a relatively new technology, complications arose when they were applied in the educational model [4].

There are currently a large number and types of technologies, so it is necessary to identify those that can be used in education and can contribute to the teaching and learning model [5][6]. Digital technologies have been implemented in all types of sectors, one of them being education; the use of these technologies results in significant improvements in educational processes and learning outcomes [7][8].

ETs are characterized as innovative technologies that provide an improvement over other traditional technologies in a specific area [6]. These technologies are not at an adequate level of maturity, because they are still under development [9]. ETs are science-based innovations with the potential to create a new industry or transform an existing one [10][11]. On the other hand, an ET is defined as a new technology that is being developed and that will substantially alter the business and social environment [10]. Other research argues that ETs are technologies that could be commercially available in the next few years (5 to 15 years), which are currently at an early stage of their development process [11][12][13].

A digital technology can be considered emergent depending on where it is being used, the domain and knowledge of its operation, and the application given to it [14]. An important characteristic of an ET is that it does not need to

have a limited lifetime, and even when it has been used for a long period of time, it can begin to become emergent when it is used in novel ways to serve people to achieve their goals [10][11]. For example, radio frequency identification (RFID) technology is not considered an ET in developed countries, whereas in other undeveloped countries, where the Internet and communication technology infrastructures are still deficient, it is considered an ET [11].

In recent years, higher education has undergone significant changes marked by technology, which alerts higher education institutions, who must try to adapt to the digital culture of their students [15]. These changes involve generating new educational strategies and methodologies based on digital technologies, which must innovate learning [15]. There are challenges that need to be addressed such as the shortage of educational materials, lack of content, lack of equipment for practices, and laboratories [9]. In this sense, digital technologies can be the solution to these problems and can help to improve the quality of teaching and contribute to the creation of new learning opportunities [16].

The use of technology as a support in education makes it flexible and stimulating for students, because they acquire skills such as spatial visualization, innovative thinking, problem solving, and analytical and critical thinking [9]. In addition, its use allows for an increase in the exchange of knowledge between teachers and students and the personalization of learning [6].

Furthermore, student acceptance of ETs is necessary to ensure the successful deployment of these technologies in support of higher education [17]. Therefore, factors affecting student acceptance of these technologies should be identified. There are isolated efforts to study the adoption and acceptance of ETs [18][19], which indicate the factors for the acceptance of individual technologies such as mobile learning, augmented reality (AR), and virtual reality (VR) [19][20] and not as ETs in a general way.

2. Emerging Technologies in Current Education

A determining factor in the process of digital transformation in the world, and especially in educational institutions, was the pandemic and the resultant restrictions due to compulsory lockdowns in various parts of the world [3][21]. The use of ETs as a support in the educational model allowed students to continue without interruption in their educational process [22]. Moreover, expectations were exceeded, not only in terms of having incorporated interactive and immersive models that enhanced student learning but also in terms of having brought education to people all over the world [6]. ETs applied to education have become a valuable learning resource because they motivate students to develop competitive skills to meet the job needs of the present and the future [23]. Innovation in education allows students to effectively use digital technologies to generate, transform, discuss, collaborate, collect, and disseminate criteria, enabling the evolution of knowledge [24]. Educational environments supported by technologies can generate interactive learning experiences, which are evaluated based on the actions, choices, and performance of the learner [25].

The variety of ETs that are implemented in education is significant. An example is VR or AR, which help create an immersive educational experience [8][26]. Teachers who have applied VR and AR in their classes notice benefits from the application of these technologies and even suggest various applications within their classrooms [27].

On the other hand, there are those technologies that allow students to access educational material from anywhere in the world, for example, mobile learning, virtual platforms, virtual classrooms, virtual libraries, etc. [28]. An initiative with the use of this technology took place at Strathmore University, who recorded their classes in a screencast and uploaded them to a server with an e-learning platform. Most of the students who watched the videos found them useful for completing assignments, retain concepts, and study for the exam [29].

Another type of ETs is social networks, which allow for constant communication between students and teachers. This enables students to have support during the fulfillment of their academic activities [30]. Additionally, social networks can be used to involve and motivate students when they are outside their classroom activities [30]. An advantage of this type of ETs is that the current generation of students grew up with access to mobile devices, internet access, and social networks, which makes them familiar with this type of technology [31][32].

Mobile devices today range from wearable, which are accessories worn on the body, to larger devices such as smartphones, tablets, and even small computers [33]. All these devices have the characteristic of being connected to the Internet, helping teachers, tutors, and mentors support students outside of school hours and school environments [7]. For example, mobile devices are used to support the teaching of English as a foreign language, allowing students to learn a language other than their native language [34].

Hardware (cameras and sensors) can be used as an innovative form of ETs in the classroom. These devices track the movement of the students' faces and capture information that, when processed, informs teachers about the satisfaction that students have with their learning [35]. In addition, by adding extra information on grades obtained, forms of evaluation, and class schedules, with the use of machine learning, it is possible to design educational, emotional, and behavioral recommendation systems, etc. [36]. Some universities in the world in the subjects of science, mathematics, technology, and engineering have adopted the development of hardware as an educational prototype using elements such as Arduino, Raspberry Pi, or BeagleBone, due to the practical value provided when using these platforms in learning [37].

One of the innovative technologies that has proliferated the most in recent years is gamification, which is based on the use of video game elements to teach and thus capture the attention and generate motivation in students [38][39][40].

Technological change is moving at an exponential rate, making it difficult for educational institutions and teachers to keep pace with it. Therefore, it is necessary to create new ways of teaching and learning and new methods for accessing educational material and for innovating in the organization of the interaction between students and teachers.

3. Technology Acceptance Models

Traditional teaching methodologies promote learning that uses memory and does not develop skills such as reading, listening, sharing, and doing [41]. For this reason, the use of digital technologies in the educational process can innovate the teaching and learning model in higher education [35]. To ensure these technologies can be used appropriately in the academic environment, the factors that may affect their adoption by students should be investigated.

The study of technology adoption by users has been conducted since the mid-1980s [42]. This is because identifying the factors that influence user acceptance is a useful prerequisite for the deployment, utilization, and realization of its potential value, regardless of the advancement of the technology [43]. There are several models that can be used to explain the acceptance of a specific technology among users. For example, the Theory of Reasoned Action (TRA) [44][45], the Technology Acceptance Model (TAM) [46][47], and the Unified Theory of Acceptance and Use of Technology (UTAUT) [48] can be useful for this. All these models have been modified, extended, and validated by multiple researchers to improve the prediction of technology acceptance and use [49]. However, UTAUT has been shown to be a model that can be used to predict user acceptance of technology use [17][50][51][52][53].

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