Emerging Technologies and Their Acceptance in Higher Education

Subjects: Computer Science, Hardware & Architecture Contributor: Santiago Criollo-C, Mario González-Rodríguez, Andrea Guerrero-Arias, Luis F. Urquiza-Aguiar, Sergio Luján-Mora

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.

Keywords: 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 ^{[Σ][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 [9].

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 $\frac{[3][21]}{2}$. The use of ETs as a support in the educational model allowed students to continue without interruption in their educational process $\frac{[22]}{2}$. 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 $\frac{[6]}{2}$. 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 $\frac{[23]}{2}$. Innovation in education allows students to effectively use digital technologies to generate, transform, discuss, collaborate, collect, and disseminate criteria, enabling the evolution of knowledge $\frac{[24]}{2}$. Educational environments supported by technologies can generate interactive learning experiences, which are evaluated based on the actions, choices, and performance of the learner $\frac{[25]}{2}$.

The variety of ETs that are implemented in education is significant. An example is VR or AR, which help create an immersive educational experience $\frac{[8][26]}{2}$. 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 $\frac{[27]}{2}$.

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 ^[I]. 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]}.

References

- 1. Diao, M.; Hedberg, J.G. Mobile and emerging learning technologies: Are we ready? EMI Educ. Media Int. 2020, 57, 233–252.
- Martínez, N.M.M.; Meneses, E.L.; Olivencia, J.J.L. El uso de las tecnologías emergentes como recursosdidácticos en ámbitos educativos. Int. Stud. Law Educ. 2018, 29, 30.
- Kutnjak, A. COVID-19 Accelerates Digital Transformation in Industries: Challenges, Issues, Barriers and Problems in Transformation. IEEE Access 2021, 9, 79373–79388.
- Martin, F.; Dennen, V.P.; Bonk, C.J. A synthesis of systematic review research on emerging learning environments and technologies. Educ. Technol. Res. Dev. 2020, 68, 1613–1633.
- 5. Márquez Díaz, J.E. Emerging Technologies Applied in Mathematics Education. Didáctica, Innovación y Multimedia, 2020(8). Available online: https://ddd.uab.cat/record/226876 (accessed on 3 March 2023).
- Ley, D. Emerging technologies for learning. In Web 2.0 and Libraries: Impacts, Technologies and Trends; Elsevier Inc.: Becta, UK, 2010; pp. 123–168.
- Criollo-C, S.; Lujan-Mora, S. M-learning and their potential use in the higher education: A literature review. In Proceedings of the International Conference on Information Systems and Computer Science, Quito, Ecuador, 23–25 November 2018; pp. 268–273.
- Criollo-C, S.; Abad-Vásquez, D.; Martic-Nieto, M.; Velásquez-G, F.A.; Pérez-Medina, J.-L.; Luján-Mora, S. Towards a new learning experience through a mobile application with augmented reality in engineering education. Appl. Sci. 2021, 11, 4921.
- Zongo, R. Integration of emerging learning technologies in secondary school: A Burkina Faso case study. In Proceedings of the 2014 International Conference on Collaboration Technologies and Systems (CTS), Minneapolis, MN, USA, 19–23 May 2014; pp. 639–640.
- Halaweh, M. Emerging Technology: What Is It? 2013. Available online: http://www.jotmi.org (accessed on 3 March 2023).
- 11. Rotolo, D.; Hicks, D.; Martin, B.R. What is an emerging technology? Res. Policy 2015, 44, 1827–1843.
- 12. Srinivasan, R. Sources, characteristics and effects of emerging technologies: Research opportunities in innovation. Ind. Mark. Manag. 2008, 37, 633–640.
- 13. Day, G.S.; Schoemaker, P.J.H.; Gunther, R.E. Wharton on Managing Emerging Technologies, 1st ed.; John Wiley & Sons: Hoboken, NJ, USA, 2000.
- 14. Bacos, C.A. Machine Learning and Education in the Human Age: A Review of Emerging Technologies; Springer: Cham, Switzerland; University of Nevada: Las Vegas, NV, USA, 2020; Volume 944, pp. 536–543.
- Guedes, D.; Almeida, P. Integrating podcasts, vodcasts, screencasts and emerging casting technologies in the teaching/learning context higher education: Potentialities, practices and expectations of students and teachers. In Proceedings of the 5th Iberian Conference on Information Systems and Technologies, Santiago de Compostela, Spain, 16–19 June 2010; pp. 1–7.

- Wisher, R.A.; Brusso, R.C.; Curnow, C.K.; Hatfield, J.; Paddock, A.; Spain, R.D. Formulating best practices and guidelines for emerging E-learning technologies. In International Handbook of E-Learning Volume 1: Theoretical Perspectives and Research; Naval Postgraduate School: Monterey, CA, USA; Taylor and Francis: Abingdon, UK, 2015; pp. 127–137.
- 17. Almaiah, M.A.; Alamri, M.M.; Al-Rahmi, W. Applying the UTAUT Model to Explain the Students' Acceptance of Mobile Learning System in Higher Education. IEEE Access 2019, 7, 174673–174686.
- Dele-Ajayi, O.; Strachan, R.; Anderson, E.V.; Victor, A.M. Technology-Enhanced Teaching: A Technology Acceptance Model to Study Teachers' Intentions to Use Digital Games in the Classroom. In Proceedings of the 2019 IEEE Frontiers in Education Conference (FIE), Covington, KY, USA, 16–19 October 2019; pp. 1–8.
- 19. Jang, J.; Ko, Y.; Shin, W.S.; Han, I. Augmented Reality and Virtual Reality for Learning: An Examination Using an Extended Technology Acceptance Model. IEEE Access 2021, 9, 6798–6809.
- Noh, N.H.M.; Idalisa, N.; Yusoff, S.; Moktar, B. Student's Acceptance of Video Lecture: An Extension of the Technology Acceptance Model (TAM). In Proceedings of the 2022 International Visualization, Informatics and Technology Conference (IVIT), Kuala Lumpur, Malaysia, 1–2 November 2022; pp. 197–201.
- 21. Rath, R.C.; Pandey, S.K.; Goel, R.; Baral, S.K. Role of Digital Technology Transformation in Computer Education: Emerging Needs and Challenges. In Proceedings of the 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions), ICRITO 2021, Noida, India, 3–4 September 2021.
- 22. Lim, S.T.; Kim, E. Exploring of the Educational Use of Emerging Technologies for Innovation in University's Future Education. J. Korean Assoc. Educ. Inf. Media 2020, 26, 311–336.
- 23. Trembach, S.; Deng, L. Understanding millennial learning in academic libraries: Learning styles, emerging technologies, and the efficacy of information literacy instruction. Coll. Undergrad. Libr. 2018, 25, 297–315.
- 24. Law, N.; Chow, A.; Yuen, A.H.K. Methodological Approaches to Comparing Pedagogical Innovations Using Technology. Educ. Inf. Technol. 2005, 10, 7–20.
- Ntlabathi, S.; Nkonki, V.J.J.V.; Mkonqo, L. Emerging technologies in Higher Education: Is it all about Learning Management Systems. Mediterr. J. Soc. Sci. 2014, 5, 117–122.
- 26. Bolstad, R.; Lin, M. Students' Experiences of Learning in Virtual Classrooms; NZCER: Wellington, New Zealand, 2009; Volume 15, p. 2012.
- Grewal, S.K.; Harris, L. Learning virtually or virtually distracted? The impact of emerging internet technologies on pedagogical practice. In Virtual Social Networks: Mediated, Massive and Multiplayer Sites; Palgrave Macmillan: London, UK, 2009; pp. 18–35.
- Olla, P.; Choudrie, J. Emerging Learning Technologies: Integrating Web2.0, Tablet PCs and Social Learning into Pedagogy; Madonna University, 36600 Schoolcraft Rd: Livonia, MI, USA, 2009; pp. 311–314. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84870283683&partnerID=40&md5=bdf2cb87e2b7b07e1e0998a9250e117f (accessed on 3 March 2023).
- 29. King'ori, R. Emerging Technologies in education: Using screencasts to increase the learning curve for undergraduate university students. A case of Strathmore University. In Proceedings of the International Conference of Education, Research and Innovation, Seville, Spain, 18–20 November 2015.
- 30. Akindele, A.; Arulogun, O.; Badmus, T.; Oluwatobi, A. Survey Dataset on Face to Face Students' intention to use Social Media and Emerging Technologies for Continuous Learning. Data Brief 2020.
- 31. Prensky, M. Digital Natives, Digital Immigrants. Horizon 2001, 9, 1-6.
- 32. Criollo-C, S.; Lujan-Mora, S.; Jaramillo-Alcazar, A. Advantages and disadvantages of m-learning in current education. In Proceedings of the EDUNINE 2018—2nd IEEE World Engineering Education Conference: The Role of Professional Associations in Contemporaneous Engineer Careers, Proceedings, Buenos Aires, Argentina, 11–14 March 2018.
- 33. Holland, B. Emerging trends in digital libraries: Mobile technology and mobile learning. In Multidisciplinary Perspectives on Telecommunications, Wireless Systems, and Mobile Computing; IGI Global: Hershey, PA, USA, 2013; pp. 229–250.
- 34. Criollo-C, S.; Guerrero-Arias, A.; Vidal, J.; Jaramillo-Alcazar, Á.; Luján-Mora, S. A Hybrid Methodology to Improve Speaking Skills in English Language Learning Using Mobile Applications. Appl. Sci. 2022, 12, 9311.
- 35. Ng'Ambi, D.; Bozalek, V. Editorial: Emerging technologies and changing learning/teaching practices. Br. J. Educ. Technol. 2013, 44, 531–535.
- Klemme, F.; Prinz, J.; van Santen, V.M.; Henkel, J.; Amrouch, H. Modeling Emerging Technologies using Machine Learning: Challenges and Opportunities. In Proceedings of the 2020 IEEE/ACM International Conference on Computer Aided Design (ICCAD), San Diego, CA, USA, 2–5 November 2020; pp. 1–9.

- 37. Al-Masri, E.; Kabu, S.; Dixith, P. Emerging Hardware Prototyping Technologies as Tools for Learning. IEEE Access 2020, 8, 80207–80217.
- Moreira, F.; Durao, N.; Pereira, C.S.; Ferreira, M.J. Mobile learning with gamification and augmented reality in portuguese high education. In Proceedings of the International Conference on Education and New Learning Technologies, Barcelona, Spain, 3–5 July 2017; pp. 4263–4273.
- Baldauf, M.; Brandner, A.; Wimmer, C. Mobile and gamified blended learning for language teaching—Studying requirements and acceptance by students, parents and teachers in the wild. In Proceedings of the 16th International Conference on Mobile and Ubiquitous Multimedia, Stuttgart, Germany, 26–29 November 2017; pp. 13–24.
- 40. Criollo-C, S.; Luján-Mora, S. Encouraging Student Motivation through Gamification in Engineering Education; Springer: Cham, Switzerland, 2019; Volume 909.
- 41. Bleustein-Blanchet, M. Lead the Change. Training Industry Magazine, 2016; pp. 16–41. Available online: https://www.nxtbook.com/nxtbooks/trainingindustry/tiq_2016spring/index.php#/p/Intro(accessed on 3 March 2023).
- 42. Garavand, A.; Aslani, N.; Nadri, H.; Abedini, S.; Dehghan, S. Acceptance of telemedicine technology among physicians: A systematic review. Inform. Med. Unlocked 2022, 30, 100943.
- 43. Qingfei, M.; Shaobo, J.I.; Gang, Q.U. Mobile Commerce User Acceptance Study in China: A Revised UTAUT Model *. Tsinghua Sci. Technol. 2008, 13, 257–264.
- 44. Fishbein, M.; Ajzen, I. Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research; Addison-Wesley: Reading, MA, USA, 1975; Volume 27.
- 45. Ajzen, I. The theory of planned behavior. Organ. Behav. Hum. Decis. Process 1991, 50, 179-211.
- 46. Briz-Ponce, L.; García-Peñalvo, F.J. An Empirical Assessment of a Technology Acceptance Model for Apps in Medical Education. J. Med. Syst. 2015, 39, 176.
- 47. Davis, F.; Bagozzi, R.; Warshaw, P. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Manag. Sci. 1989, 35, 903–1028.
- Criollo-C, S.; Lema, M.; Gonzalez, M.S.; Jaramillo-Alcázar, A.; Guerrero-Arias, A.; Luján-Mora, S. Exploring the technological acceptance of a mobile learning tool used in the teaching of an indigenous language. PeerJ Comput. Sci. 2021, 7, e550.
- 49. Venkatesh, V.; Morris, M.G.; Davis, G.B.; Davis, F.D. User Acceptance of Information Technology: Toward a Unified View. MIS Q. 2003, 27, 425–478.
- 50. Kar, S.; Kar, A.K.; Gupta, M.P. Industrial Internet of Things and Emerging Digital Technologies–Modeling Professionals' Learning Behavior. IEEE Access 2021, 9, 30017–30034.
- 51. Alghazi, S.S.; Kamsin, A.; Almaiah, M.A.; Wong, S.Y.; Shuib, L. For Sustainable Application of Mobile Learning: An Extended UTAUT Model to Examine the Effect of Technical Factors on the Usage of Mobile Devices as a Learning Tool. Sustainability 2021, 13, 1856.
- 52. Chavoshi, A.; Hamidi, H. Social, individual, technological and pedagogical factors influencing mobile learning acceptance in higher education: A case from Iran. Telemat. Inform. 2019, 38, 133–165.
- 53. Hamidi, H.; Chavoshi, A. Analysis of the essential factors for the adoption of mobile learning in higher education: A case study of students of the University of Technology. Telemat. Inform. 2018, 35, 1053–1070.

Retrieved from https://encyclopedia.pub/entry/history/show/120964