CONCEPTIONS ON HIGHER EDUCATION PROFESSORS ABOUT USE OF TECHNOLOGIES IN THE LEARNING PROCESS: A COMPARATIVE STUDY

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Abstract

A panoply of new trend technologies can be applied in an innovative approach for the education sector. The proposed technologies are Virtual and Augmented Reality (AR/VR), Blockchain (BC), 5G and Artificial Intelligence (AI). The main topics researched in this publication are: Identify the technologies that are being used to enhance the dissemination of knowledge in the learning process and the professor's receptiveness to learning experiences based on these technologies. A section of this article provides a research work through the enrolment of professors in a focus group conducted in two distinct Universities to enquire the students about their Information Technology knowledge, awareness, and preferences for the adoption of AR, VR, BC and AI as new tools in the classes and Campus. The two focus groups consisted of two Universities. The interviews were transcribed with the support of the qualitative analysis software, webQDA. The data collected was triangulated and validated according to the Delphi method, for greater validity and reliability of the results. From the main results, the following three categories were identified: i) challenges: big-data hosting, cultural adoption, integration issues, nascent technology, control, security and privacy; ii) advantages: user empowerment, high quality data, durability, reliability, longevity, process integrity, and disadvantages: instability, energy consumption, cost of creation, maintenance of technologies and platforms where they are allocated, gigantic human effort, highly competent human resources, maintenance of platforms and associated technologies. The article concludes that the use of technologies for professors at both Universities is an attractive evolutional path for lecturing with some limitations, that are dependent of the lecturer profile and course curriculum.

Keywords: Professors; Conceptions on use of technologies; Higher Education; Learning Process.

1 INTRODUCTION

Advances in immersive learning technologies present opportunities to explore a variety of pedagogical methods in educational environments. A scenario of a cost-effective Virtual and Augmented Reality (AR/VR) portable solution will, for sure, enrich the students experience. Terms such as Location Based Services (LBS) are more and more currently used, the same with Augmented Reality and Virtual Reality (AR/VR), IoT (Internet of Things), Blockchain (BC) and Artificial Intelligence (AI). Normally, these terms appear linked with the prospect of innovation by embedding new technologies in to the pedagogic processes, to improve outcomes in learning and teaching methodologies, also linked with the notion of active methodology and involvement in school processes [1], [2], [3].

The research question that arises is: how technologies can be an asset for learning in higher education. Lecturing in the XXI century will, for sure, launch a new set of challenges. In this research, the authors plan to understand how the new trend technologies can become relevant tools for the new learning actors: the level of knowledge and the openness for its application.

This study is based in a qualitative approach, recurring to focus group is a method. The focus group was composed by teachers in two private Higher Education Institutions (HEI) in Northern Portugal. We aimed to identify the technologies that are being used to enhance the dissemination of knowledge in the learning process and the professor's receptiveness to learning experiences based on these technologies or teaching approaches molded by them. In resume, the qualitative way of addressing the mental representations of teachers allowed to expose their posture regarding the new technologies and pedagogical innovation they potentiate. We adopt a prospective posture, that normally must be previous to any changes proposed regarding teaching methodologies or new ways of living the school space.

2 LECTURING IN THE XXI CENTURY

Clearly, there is a running evolution of the academic community over the past five decades in the context of theories of the “University of Excellence” [4].

The constant evolution in technology raises the need for continuous new challenges for higher education institutions that are training, for example, engineers. These changes should directly impact in the curricula of the Universities to bring the new required skills to the XXI students [5]. Also, the conventional engineering educational strategies: lectures, laboratory experiments and homework. Most of them created as teacher-oriented are not the adequate strategy for the new era students. Typically, there are two main reasons appointed in the literature for the inadequacy. They are not able to prepare the student to engage in collaborative team and thy do not promote active learning, on the other hand they are contributing to compartmentalized curriculum [6].

The advancement and proliferation of smart and wireless technologies are transforming the educational process into a smart system that provides seamless learning process [7].

Also, pushed by the pandemic COVID-19 new lecturing approaches such as online classes have quickly emerged as common practices – bringing a panoply of new platforms that provide the desired service [8], [9].

Several literature studies point out the extreme relevance of bringing IT technologies as a lever to better lecturing practices [10], [11], [12]. The smart devices are the interface needed to do the suport bridge between IT and the university [13].

The concept of “Smart University” has also being a topic of research. The strong impact of advanced technologies such as AI, IOT and big data are enhancing the performance of lecturing activities and univestity magement supor systems [14]. The relevant issue of paperless univestities is also of extreme relevance [15]. Also, as relevant issue, the university campus can be a rich simulation and living lab for contributing to a sustainable develoment and resilience and all the results, threw IoT and data science, achieved in the smart campus can be applied to real cities [16], [17].

3 TECHNOLOGIES AND SCENARIOS FOR LECTURING

The following sections present the state-of-the art on the use of several trend technologies in the educational environment.

3.1 Location Based Services (LBS)

The University campus is the playground for all the services related to the lecturing actors. The real the knowledge of the positioning can be relevant in order to provide the best services. This practice should always take into consideration all the privacy issues and taking into consideration the General Data Protection Regulation (GDPR) [18]. This issue can be addressed with the support of BC technology, presented in the next sections [19], [20] or with the support of other implementations as stated in the literature [21], [22], [23], [24], [25], [26], [27].

The issue of positioning in the university campus can be address in two distinct scenarios: indoor and outdoor. For the oudoor location – the classical approach of GPS combined with Wi-Fi and Bluettoth are the most refered technical approaches in the literature [28], [29], [30], [31], [32], [33].

The LBS approcah can bring a set of new services: a lectuter walking in a university corridor can be informed of an event that is starting in a nearby location; a teacher is on real-time informed about the attendance order; a secure payment is authorised when the user is near a vending machine; a class-room is unlock when the teacher reaches the class-room.

3.2 AI

The on-going Artificial Intelligence (AI) revolution has disrupted several industry sectors and will keep having an unprecedented impact on all areas of society. This has led to a growing demand for multidisciplinary AI education also for students outside computer science [34]. It is expected a rapid integration of AI technology in the education sector. This will, directly, impact in the teaching ideas, forms, contents, methods and will bring a positive pressure on the requirements for teacher’s professional quality and their teaching ability. The literature points the importance of AI quality cultivation and application ability training. The digital literacy, computational thinking, programming ability and deep

cognition of intelligent society are the important contents of AI technology literacy of normal university students [35].

University actor must connect do the administrative departments for several kind of support required. This is always a time-consuming process and also requires adequate manpower for an efficient service. The literature points out AI solutions supported by Chabot [36]. The chatbot approach can even be implemented under commom communications applications like WhasApp [37]. The addicted behaviour of the young students to communications tools can be a tool for monitoring student participation, as stated in the literature [38].

The smart support of AI tools as an lecturing enhancement is also describe in the literature, in particular for the teachong of foreigner languages and engineering [39], [40], [41], [42], also combined with onlline lecturing platforms [43], [44]. The possibilty of developing self-learning activities is also of great relevance [39]. There is also a relevant role in the education of students with disabilities, using AI based interactive voice conversations [45], [46].

The literature describes, also, some ideals and suggestions on the development of professional ability of secondary vocational teachers in the era of artificial intelligence [47].

3.3 IoT

To monitor and represent real stimulus about the topics under lecturing, Internet of Things (IoT) can be an impressive tool. The ability to bring Internet Protocol (IP) to common and ordinary devices opens a rich assortment of novel applications. There are a huge number of solutions for digital education. These tools can provide support for successfully conducting the lecture class in a university. From online video source (e.g., YouTube), interactive communication channel (e.g., Google Hangouts, Facebook Messenger, WhatsApp). However, typically, these tools miss the final necessary link: monitor and generation of real-life environment conditions. So it is fundamental to take into consideration the students attendance, activities and intention to pay attention as a part of assessment and provide appropriate education tools to improve the education quality as suggested in the literature [48]. The IoT can detect and sense the environmental conditions (eg. room temperature, student's activities and behavior) and produce the necessary stimulus.

On distance learning, some studies, suggest that IoT in distance learning and self-education allow to increase the efficiency of studying up to 20% more. During the video lesson the IoT devices are monitoring the level of the brain activity and sending the feedback to the software program [49].

The fast proliferation of IoT in the industry but also as a lever of learning management system (LMS), lecture capture method, big data analytics, and instructional tools of all educational system activities. The integration of this technology in higher education systems will save time, improve student's skills and work for a better student's preparations [50].

The literature describes a mythology for automation of the University by providing an efficient, scalable and affordable solution to support the process of teaching and learning for the learning actors – exploiting the concept of smart classrooms [51], [52]. Simple tasks such as attendance tracking/monitoring System in IoT can be implemented [53].

The process of instrumenting a classroom with IoT sensors can help measuring in real-time the classroom usage, to predict the attendance, and performing optimal allocation of rooms to courses so as to minimize space wastage [54].

3.4 BC

The Blockchain (BC) technology is a relevant tool to support the integrity and security of a set of data. In particular, and as described in the previous sections the implementation of smart classrooms, smart university campus and smart learning means a massive collect of data from the learning actors. This data should have collected should grant the necessary privacy and security – in order to avoid legal and personal constrains [55].

All the relevant teacher certification and personal data can be stored under a BC structure [56].

Education institutes have a long experience of collaboration. The creation of educational resources and the necessary precaution about ownership of the contents – it is always a pertinent issue. The literature proposes a BC technology solution in a collative approach to record multiple authorship when using

other people's work. So, this way, the author can track their work and claim, if justified, some benefit from the others usage [57].

The concerns about the design of data certification system with the support of BC is also presented for the use case of Automotive teaching [58]. The literature also sustains the creation of a fully Decentralized Online Education Platform threw a BC solution [59].

Several challenges of adopting BC for IoT-enabled education systems are addressed so that the practitioners can acquire innovative technologies in the field of education more quickly in near future [60]. In order to control the remote access to specific laboratory facilities – the BC can also be a relevant solution [61].

3.5 AR/VR

The new learning playground should be a rich content immersive experience for the lecturer and for the student, opening the way to Augmented Reality (AR) and Virtual Reality (VR). The possibility of adding new elements to our realty (AR) or even developing the best scenario for a particular learning experience (VR) are the key for this disruption in the learning act. A relevant study about is teacher acceptance of AR as a teaching resource is presented [62].

A research article analyzes the motivation of high school students and teachers to use a free online Augmented Reality (AR) application as a tool for learning/teaching basic concepts of direct-current (dc) circuits. The great potential of the rich content generated is a huge advantage [63]. The overall perception of the learning actors is also positive for the adoption of VR approaches [64].

AR as a technology is evolving along with increasing use of human technology. A use case of Astronomy application is presented [65] sustaining Smartphone is an important device that everyone can carry and use in their everyday life. The integration of the mobile device and AR technology has been increasingly adopted in various fields including Education.

Some topics - which aims at helping students understand how complex systems emerge and the causal mechanism underlying such adaptive systems are most of the time critical for the student's perception, an AR game is proposed to solve this issue [66].

In laboratory simulation environments AR is also a relevant technology: an AR based virtual educational robotics learning system which aims to support the learning activities of computational thinking and STEM education (science technology engineering and mathematics) is described in literature [67].

The improvement of the lecturer skills can, also, be improved by a VR training solution [68]. Improving teachers' communicative competence and their ability to manage conflict affecting the classroom climate is also refered [69].

A pilot study of four teacher avatars for an educational virtual field trip presents a guideline that will measure the educational efficacy of revised avatars in the lecturing process [70].

A tool that can measure the student's attention and fatigue can be implemented in order to optimize the learning experience [71]. Also, and in order to help teachers understand and manage students in such an environment, an interface was presented to support teacher awareness of students and their actions, attention, and temperament in a social VR environment [72].

4 METHODOLOGY

Within qualitative research studies, focus group is a method that has been developed. The focus group was held in two private Higher Education Institutions (HEI) in Northern Portugal. General Objective: Identify the technologies that are being used to enhance the dissemination of knowledge in the learning process and the professor's receptiveness to learning experiences based on these technologies.

A literal transcription of a speech was performed, as evidence of a statement / interpretation made by the two researchers, authors of the paper [73], one in every HEI. There are several types of research analysis: a) in a real context; b) classroom interactions; c) analysis of teaching skills [74]. But the one that will be used will resort to the webQDA® software, which provides users with video data analysis, which is non-numeric and unstructured data.

The two researchers and authors of the study looked for meaning units that supported categories of analysis. This construction process implied an ideographic approach since the categories were defined *a posteriori*.

To maintain the confidentiality of the studied contexts, the anonymity of all the professors, as well as the confidentiality of the HEIs, one proceeded to their identification by P1 and P2 and P3 in HEI one and P3, P4, P5, P6 and P8, in the HEI two.

The study was conducted in November 2020. The sample consists of 3 professors from HEI one and 5 professors HEI 2 (who voluntarily participated in education research), from private higher institutions in the North of Portugal. At University one - two engineering and one management professors; at university two - one professor in the area of Education, one in Sports, one in Technologies, one in Management and at last one in Education for Special Educational Needs.

The data collection procedure was performed by invitation for investigation, in writing, addressed to the Directors of Higher Education Institutions, and Professors were asked for permission, in writing, to record for later use in research, safeguarding the anonymity of students and all ethical issues involved. These lasted, on average, 30 minutes.

Considering the objectives of the study, one tried to provide a detailed and rigorous description, to guarantee the validity or credibility of the qualitative study [75]. It was also chosen to focus on data triangulation, the results of the analysis of the content the focus group of the professors between the two HEIs crossed - a modality that proves if the information collected is confirmed by others and turning to the transparency of the whole process that guarantees the reader the merit, credibility and reliability.

The interviews were transcribed. With the support of the qualitative analysis software, webQDA, the data resulting from the content analysis of the interviews of the two Universities and document analysis were triangulated and validated according to the Delphi method, for greater validity and reliability of the results. From the main results, the following three categories were identified: i) challenges: big-data hosting, cultural adoption, integration issues, nascent technology, control, security, and privacy; ii) advantages: user empowerment, high quality data, durability, reliability, longevity, process integrity, and iii) disadvantages: instability, energy consumption, cost of creation.

5 RESULTS

In this study, one will present the categories and indicators of the data, represented in Table 1.

Table 1. Categories and Indicators and References Units in the two HEIs

Categories	***Indicators***	***References Units HEI1 (n)***	***References Units HEI2 (n)***
Challenges	Big-data hosting	2	1
	Cultural adoption	1	1
	Integration issues	1	1
	Nascent technology	1	1
	Control	1	
	Security and privacy	1	
Advantages	User empowerment	1	
	High quality data	1	1
	Durability	1	1
	Reability	1	1
	Longevity	1	1
	Process integrity	1	1
Disadvantages	Instability	1	
	Energy consumption		3
	Cost of creation	1	

Source: The authors

In the case of HEI1 professors the most mentioned big data hosting (n = 2) was control, for example "implementation of new technologies, have some doubts highlighted is the concrete usefulness of the technologies, that is, for the investment made in terms of resources, and then the practical usefulness of the technologies used".

In the case of HEI2, professors do not highlight is the concrete usefulness of the technologies, that is, for the investment made in terms of resources, and then the practical usefulness of the technologies used. In the case of HEI2, teachers do not agree with the introduction of new technologies in the classroom due to the difficulty teachers may have in adapting, as mentioned in Nascent technology (n = 1), example “the pedagogical advantage of the use of technologies, and some subjects are likely to be taught with the help of these technologies, other subjects are not as reversible to these technologies and should be taught in a more classical way."

In the case of HEI1, professors the most mentioned big data hosting (n =2) was control, for example "implementation of new technologies, have some doubts related to the material and human resources that are necessary to implement these technologies”. They don’t mention energy costs, but professors say “One of the aspects that is highlighted is the concrete usefulness of the technologies, that is, for the investment made in terms of resources, and then the practical usefulness of the technologies used ”.

In the case of HEI2, professors do not agree with the introduction of new technologies in the classroom due to the difficulty professors may have in adapting, as mentioned in Nascent technology (n = 1), example “the pedagogical advantage of the use of technologies, and some subjects are likely to be taught with the help of these technologies, other subjects are not as reversible to these technologies and should be taught in a more classical way." They mention Energy Consumption (n = 3) as a cost and in and for it’s possible environmental impact.

6 CONCLUSIONS

Due the logistics involved in implementing new technologies, they have some doubts that have to do with the material and human resources needed to implement these technologies. Issues such as hosting and accessing big data, purchasing software and hardware, maintenance, teams of people dedicated to the development and implementation of these technologies. One of the aspects that is highlighted is the concrete usefulness of the technologies, that is, for the investment that is made in terms of resources, and then the practical usefulness of the technologies used. They point out that in terms of innovation applied to teaching, all technologies are very interesting, and if possible, they should be implemented, developed, and used.

The interviewees speak of the pedagogical benefit of the use of technologies, and some subjects are likely to be taught with the help of these technologies, other subjects are not so reversible to these technologies and should be taught in more classical ways. Other technologies can be used in very restricted terms, in small demonstration applications, as in the case of virtual reality. In the case of blockchain, the issue of resources to allocate to an information chain arises, and issues related to access passwords and access authorizations, permanent updating of data also raise issues. Technologies (NFC, Bluetooth, Wi-Fi) may have a use, but it is mainly in administrative terms, not pedagogical ones. Briefly, everyone agrees on the benefits to be derived from the use of these technologies, but doubts arise when it comes to evaluating the investment and return provided using these technologies. Most likely the curricula content would have to be reconstructed again to adapt to these technologies. Some teachers would find it easy to adapt, and adapt to the use of these technologies, but many teachers would have to make a huge effort to adapt. Others would not be able to use them. The same would happen with the students, who would have to be very involved in the daily life of the classes.

REFERENCES

[1] J. C. Morais, J. C. Monteiro J. D. Santos, L. A. Soveral, N. Neves, S. O. Sá, “Distance learning: teaching seen by higher education professors under Covid-19,” EDULEARN21 Proceedings 13th International Conference on Education and New Learning Technologies, July 5-6. Pages: 2870-2873, 2021.doi.org/10.21125/edulearn 2021.

[2] J. C. Morais, J. C. Monteiro, J. D., Santos, L. Soveral, N. Neves, S. O. Sá, “Distance learning: learning seen by higher education students under Covid-19,” In: Gómez Chova, L., López Martínez, A., Candel Torres, I. (Eds.) EDULEARN21 Proceedings 13th International Conference on Education and New Learning Technologies, July 5-6, IATED Academy, pp. 2881-2885, 2021. doi.org/10.21125/edulearn.2021.

[3] S. O. Sá, J. C. Morais, F. Almeida, “As metodologias ativas como estratégias para o desenvolvimento de competências de Inteligência Emocional nos estudantes do Ensino Superior,” In S. O. Sá, F. Freitas, P. A. Castro, M. G. Sammamed, & A. P. Costa (Eds.), *Investigação Qualitativa em Educação: Avanços e Desafios*. New Trends in Qualitative Reasearch – Qualitative research in Education: Advances and Challenges. (vol. 2, pp. 55-68). Oliveira de Azeméis: Ludomedia 2020. https://doi.org/10.36367/ntqr.2.2020.55-68.

[4] Z. Lingxi, Y. Hao, “University of Excellence,”*2010 International Conference on Education and Management Technology*, 2010.

[5] C. M.Zea, A., Rodriguez, & N. A. Bueno, “An innovation model in curriculum design for teaching engineering at universidad EAFIT,” *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, 2014.

[6] J. Macedo, M. Pinho-Lopes, C. G., Oliveira, & P. C. Oliveira, “Two Complementary Active Learning Strategies in Soil Mechanics Courses: Students’ Perspectives,” *2020 IEEE Global Engineering Education Conference (EDUCON)*, 2020.

[7] G., Yusufu, & N. Nathan, “A Novel Model Of Smart Education For The Development Of Smart University System,” *2020 International Conference in Mathematics, Computer Engineering and Computer Science (ICMCECS)*, 2020.

[8] M. Wende, S. Bulut, T. Giese, & R. Anderl, “Online Lectures – Strategies for Applying Advanced Digital Media for Future Higher Education,” *2020 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, 2020.

[9] A. S., Won, J. O. Bailey, S. Yi, “Work-in-Progress—Learning about Virtual Worlds in Virtual Worlds: How Remote Learning in a Pandemic Can Inform Future Teaching,” *2020 6th International Conference of the Immersive Learning Research Network (iLRN)*, 2020.

[10] T. Zarraonandia, P. Diaz, & I. Aedo, “Foreseeing the Transformative Role of IT in Lectures,” *2011 IEEE 11th International Conference on Advanced Learning Technologies*, 2011.

[11] J. A. Pow-Sang, “Replacing a traditional lecture class with a jigsaw class to teach analysis class diagrams,” *2015 International Conference on Interactive Collaborative Learning (ICL)*, 2015.

[12] J. Liebehenschel, “Digitization of a Lecture - An Experience Report. *2020 IEEE Global Engineering Education Conference (EDUCON)*, 2020.

[13] N. Chen, & Y. Yamashita, “The Possibility for the Active Use of Smart Devices in University Education,” *2017 6th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*, 2017.

[14] T. V. Pham, A. T. Nguyen, T. D. Ngo, D. H. Le, K. C. Le, T. H. Nguyen, & H. Q. Le, “Proposed Smart University Model as a Sustainable Living Lab for University Digital Transformation,” *2020 5th International Conference on Green Technology and Sustainable Development (GTSD)*, 2020.

[15] S. Jain, R. Garg, V. Bhosle, & L. Sah, “Smart university-student information management system,” *2017 International Conference On Smart Technologies For Smart Nation (SmartTechCon)*, 2017.

[16] I. Negreiros, A. C. Francisco, F. H Fengler, G. Faria, L. G. Pinto, M., Tolotto, R. S Netto, “Smart Campus® as a living lab on sustainability indicators monitoring,” *2020 IEEE International Smart Cities Conference (ISC2)*, 2020.

[17] M. G. Aguilar, V. M. Rosillo, C. O. Perez, M. R. Arellano, J. R. Ramirez, & J. A. Trejo, “Analysis of Wastewater Production to Implement Circular Economy Solutions in a Smart Cities University Campus Living Lab,” *2019 IEEE International Smart Cities Conference (ISC2)*, 2019.

[18] V. Ayala-Rivera, & L. Pasquale, “The Grace Period Has Ended: An Approach to Operationalize GDPR Requirements,” *2018 IEEE 26th International Requirements Engineering Conference (RE)*, 2018.

[19] J.Ahmed, S. Yildirim, M. Nowostaki, R. Ramachandra, O. Elezaj, & M. Abomohara, “GDPR Compliant Consent Driven Data Protection in Online Social Networks: A Blockchain-Based Approach,” *2020 3rd International Conference on Information and Computer Technologies (ICICT)*, 2020.

[20] B. Li, R. Liang, W. Zhou, H. Yin, H. Gao, & K. Cai, ”LBS Meets Blockchain:an Efficient Method with Security Preserving Trust in SAGIN,” *IEEE Internet of Things Journal*, 2021.

[21] J. Tang, H. Zhu, R. Lu, X. Lin, H. Li, & F. Wang, “DLP: Achieve Customizable Location Privacy with Deceptive Dummy Techniques in LBS Applications,” *IEEE Internet of Things Journal*, 2021.

[22] Y. A. lsaawy, , A. Alkhodre, F. A. Eassa, &, A. A. Sen, “Triple Cache Approach for Preserving Privacy and Enhancing Performance of LBS,” *2019 6th International Conference on Computing for Sustainable Global Development (INDIACom)*, 2019.

[23] C. Ma, Z. Yan, & C. W. Chen, “SSPA-LBS: Scalable and Social-Friendly Privacy-Aware Location-Based Services,” *IEEE Transactions on Multimedia*, 2019.

[24] H. Zhang, L. Xu, H. Huang, & S. Gao, “Mining spatial association rules from LBS anonymity dataset for improving utilization,” *2013 21st International Conference on Geoinformatics*. 2013.

[25] P. Zhao,J. Li, F. Zeng, F. Xiao, C. Wang, & H. Jiang, “ILLIA: Enabling k -Anonymity-Based Privacy Preserving Against Location Injection Attacks in Continuous LBS Queries,” *IEEE Internet of Things Journal*, 2018.

[26] J. Jia, F. Zhang, & R. Wu, “An encryption-based k-anonymity approach for location privacy protection in LBS,” *Proceedings 2013 International Conference on Mechatronic Sciences, Electric Engineering and Computer (MEC)*, 2013.

[27] F.-Y. Tai, J.-K. Song, Y.-C Tsai, & H.-P. Tsai, “Cloaking sensitive patterns Td preserve location privacy for LBS applications,” *2016 IEEE International Conference on Consumer Electronics-Taiwan (ICCE-TW)*, 2016.

[28] F. V. Diggelen, “A-GPS: Assisted GPS, GNSS, and SBAS,” *Artech*, 2009.

[29] Z., Özdemir, & B. Tuğrul, “Geofencing on the Real-Time GPS Tracking System and Improving GPS Accuracy with Moving Average, Kalman Filter and Logistic Regression Analysis,” *2019 3rd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT)*, 2019.

[30] W. Gao, L. Pei, C. Xu, & P. Liu, “Crowdsensing-based organic fingerprint for Wi-Fi localization,” *2016 Fourth International Conference on Ubiquitous Positioning, Indoor Navigation and Location Based Services (UPINLBS)*, 2016.

[31] Y.-H. Wen, H.-S. Chang, H.-W. Kao, & G.-H. Ju, “Location-aware services based on Wi-Fi network,” *The 16th Asia-Pacific Network Operations and Management Symposium*, 2014.

[32] L. Pei, J. Liu, R., Guinness, Y., Chen, T. Kröger, R. Chen, & L. Chen, “The evaluation of WiFi positioning in a Bluetooth and WiFi coexistence environment,” *2012 Ubiquitous Positioning, Indoor Navigation, and Location Based Service (UPINLBS)*, 2012.

[33] M. Ji, J. Kim, J. Jeon, & Y. Cho, “Analysis of positioning accuracy corresponding to the number of BLE beacons in indoor positioning system. *2015 17th International Conference on Advanced Communication Technology (ICACT)*, 2015.

[34] S. Laato, H. Vilppu, J. Heimonen, A. Hakkala, J. Björne, A. Farooq, A. Airola, “Propagating AI Knowledge Across University Disciplines- The Design of A Multidisciplinary AI Study Module,” *2020 IEEE Frontiers in Education Conference (FIE)*, 2020.

[35] S. Liu, & X. Xie, “AI Quality Cultivation and Application Ability Training for Normal University Students,” *2021 7th Annual International Conference on Network and Information Systems for Computers (ICNISC)*, 2021.

[36] N. P. Patel, D. R. Parikh, D. A. Patel, & R. R. Patel, “AI and Web-Based Human-Like Interactive University Chatbot (UNIBOT),” *2019 3rd International conference on Electronics, Communication and Aerospace Technology (ICECA)*, 2019.

[37] A. Ramaditiya, S. Rahmatia, A. Munawar, & O. N. Samijayani, Implementation Chatbot Whatsapp using Python Programming for Broadcast and Reply Message Automatically. *2021*. (s.d.).

[38] D. Bailey, & N. Almusharraf, “Investigating the Effect of Chatbot-to-User Questions and Directives on Student Participation,” *2021 1st International Conference on Artificial Intelligence and Data Analytics (CAIDA)*, 2021.

[39] J. Zhou, “Design of AI-based self-learning platform for college English listening,” *2020 2nd International Conference on Machine Learning, Big Data and Business Intelligence (MLBDBI)*, 2020.

[40] A. Begel, “Best Practices for Engineering AI-Infused Applications: Lessons Learned from Microsoft Teams,” *2019 IEEE/ACM Joint 7th International Workshop on Conducting Empirical Studies in Industry (CESI) and 6th International Workshop on Software Engineering Research and Industrial Practice (SER&IP)*, 2019.

[41] H. K. Simonsen, “AI Writers in Language Learning,” *2021 International Conference on Advanced Learning Technologies (ICALT)*, 2021.

[42] D. Wen, & F. Lin, “Ways and Means of Employing AI Technology in E-Learning Systems,” *2008 Eighth IEEE International Conference on Advanced Learning Technologies*, 2008.

[43] M. Chen, M. Siu-Yung, C. S. Chai, C. Zheng, & M.-Y. Park “A Pilot Study of Students’ Behavioral Intention to Use AI for Language Learning in Higher Education,” *2021 International Symposium on Educational Technology (ISET)*, 2021.

[44] R. L. Sie, J. Delahunty, K. Bell, A. Percy, B. Rienties, T. Cao, & M. D. Laat, Artificial Intelligence to Enhance Learning Design in UOW Online, a Unified Approach to Fully Online Learning,” *2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, 2018.

[45] A. Rajagopal, & N. Vedamanickam, “New Approach to Human AI Interaction to Address Digital Divide& AI divide: Creating an Interactive AIplatform to Connect Teachers & Students,” *2019 IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT)*, 2019.

[46] V. Andrunyk, & O. Yaloveha, “Information System for Monitoring the Emotional State of a Student With Special Needs Using AI,” *2020 IEEE 15th International Conference on Computer Sciences and Information Technologies (CSIT)*, 2020.

[47] L. Liu, Y. Zhang, P. Zhang, & W. Sun, “Reflections and Countermeasures on the Development of Secondary Vocational Teachers’ Teaching Ability Based on AI and Students’ Characteristics,” *2020 International Conference on Artificial Intelligence and Education (ICAIE)*, 2020.

[48] Y.Tew, T. Y. Tang, & Y. K. Lee, “A study on enhanced educational platform with adaptive sensing devices using IoT features,” *2017 Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA ASC)*, 2017.

[49] R. Yakoubovsky, & V. Sarian, “IoT in Effective Distance Learning Process,” *2021 1st International Conference on Technology Enhanced Learning in Higher Education (TELE)*, 2021.

[50] G. A. Abdelhady, & M. A. Mouez, “Survey on IoT based education system, case study: MSA university,” *3rd Smart Cities Symposium (SCS 2020)*, 2020.

[51] M. A. Rahman, Q. A. Farooqui, & K. Sridevi, “IoT based Comprehensive Approach Towards Shaping Smart Classrooms,” *2021 Fifth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, 2021.

[52] A. K., Kanál, & K. Tamás, Assessment of Indoor Air Quality of Educational Facilities using an IoT Solution for a Healthy Learning Environment. *2020 IEEE International Instrumentation and Measurement Technology Conference (I2MTC)*, 2020.

[53] J. Dixon, & A.-s. Abuzneid, “An NFC Based Student Attendance Tracking/Monitoring System Using an IoT Approach,” *2020 International Conference on Computational Science and Computational Intelligence (CSCI)*, 2020.

[54] T. Sutjarittham, H. H., Gharakheili, S. S., Kanhere, & V. Sivaraman, Experiences With IoT and AI in a Smart Campus for Optimizing Classroom Usage. *EEE Internet of Things Journal*, 2019.

[55] H. Desai, M. Kantarcioglu, & L. Kagal, “A Hybrid Blockchain Architecture for Privacy-Enabled and Accountable Auctions,” *2019 IEEE International Conference on Blockchain (Blockchain)*, 2019.

[56] A. L. Franzoni, C. Cárdenas, & A. Almazan, “Using Blockchain to Store Teachers' Certification in Basic Education in Mexico,” *2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT)*, 2019.

[57] H. C. Chou, “A Blockchain-based Collaboration Framework for Educational Material Sharing,” *2020 IEEE 8th R10 Humanitarian Technology Conference (R10-HTC)*, 2020.

[58] X. Zhang, “Research on Information Management Platform of Automobile Teaching Equipment Based on Blockchain,” *2020 5th International Conference on Electromechanical Control Technology and Transportation (ICECTT)*, 2020.

[59] X.-d., Chen, J. Lu, M. Gong, B.-J. Guo, & Y.-p. Xu, Design And Implementation Of Decentralized Online Education Platform. *2020 5th International Conference on Mechanical, Control and Computer Engineering (ICMCCE)*, 2020.

[60] S. T Siddiqui, M. Fakhreldin, & S. Alam, “Blockchain Technology for IoT based Educational Framework and Credentials,” *2021 International Conference on Software Engineering & Computer Systems and 4th International Conference on Computational Science and Information Management (ICSECS-ICOCSIM)*, 2021.

[61] E., Werner, J. C. Matias, M. D., Berejuck, & H. Saliah-Hassane, “Evaluation of blockchain techniques to ensure secure access on remote FPGA laboratories,” *2021 9th International Symposium on Digital Forensics and Security (ISDFS)*, 2021.

[62] G. Banerjee,& S. Walunj, “Exploring in-Service Teachers' Acceptance of Augmented Reality,” *2019 IEEE Tenth International Conference on Technology for Education (T4E)*, 2019.

[63] D. Urbano, M. D., Chouzal, & M. T Restivo, “How students and teachers react to an AR free puzzle game: Preliminary tests,” *2015 IEEE Global Engineering Education Conference (EDUCON)*, 2015.

[64] H. Sulaiman, N. Ibrahim, R. A. Latif, & A. M. Yusof, “Students and Teachers’ Perception on future use of Virtual Reality (VR) in learning Physics: A Preliminary Analysis,” *2020 IEEE Conference on e-Learning, e-Management and e-Services (IC3e)*, 2020).

[65] Putiorn, P., Nobnop, R., Buathong, P., & Soponronnarit, K. (2018). Understanding Teachers' Perception Toward the Use of an Augmented Reality-Based Application for Astronomy Learning in Secondary Schools in Northern Thailand. *2018 Global Wireless Summit (GWS)*.

[66] Su, M. (2021). Work-in-Progress——AR-supported Collaborative Game for Understanding Complex Systems. *2021 7th International Conference of the Immersive Learning Research Network (iLRN)*.

[67] Yang, F.-C. O. (2019). The Design of AR-based Virtual Educational Robotics Learning System. *2019 8th International Congress on Advanced Applied Informatics (IIAI-AAI)*.

[68] J.-L. Lugrin, S. Oberdorfer, M. E. Latoschik, A. Wittmann, C. Seufert, & S. Grafe, “VR-Assisted vs Video-Assisted Teacher Training,” *2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*, 2018.

[69] M. M. Cárdenas, I. M. Álvarez, A. Romero, & B. Manero, “A Teacher Training Proposal for Classroom Conflict Management through Virtual Reality,” *2021 International Conference on Advanced Learning Technologies (ICALT)*, 2021.

[70] J. W. Woodworth, N. G. Lipari, & C. W. Borst, “Evaluating Teacher Avatar Appearances in Educational VR,” *2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*, 2019.

[71] A. Khokhar, A. Yoshimura, & C. W. Borst, “Pedagogical Agent Responsive to Eye Tracking in Educational VR,” *2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*, 2019.

[72] D. M. Broussard, Y. Rahman, A. K., Kulshreshth, & C. W. Borst, “An Interface for Enhanced Teacher Awareness of Student Actions and Attention in a VR Classroom,” *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, 2021.

[73] A. P. Costa, F. Neri de Sousa, A., Moreira, D. Neri de Souza, “webQDA — Qualitative data analysis software: Usability assessment. In *2016 11th Iberian Conference on Information Systems and Technologies (CISTI),* pp. 1–6. Las Palmas, IEEE, 2016. http://doi.org/10.1109/CISTI.2016.7521477

[74] S. P. Gonçalves, J. P. Gonçalves, C. G. Marques, “*Manual de Investigação Qualitativa: conceção, análise e aplicações,”* Edições Pactor, Lisboa, 2021.

[75] J. Amado, A. Costa, N. Crusoé, A técnica de análise de conteúdo. *In Manual de Investigação qualitativa em educação*, (2nd ed, pp. 301–355). Coimbra University Press, Coimbra, 2017. doi: http://dx.doi.org/10.14195/978-989-26-0879-2