International Journal of Computing Sciences Research (ISSN print: 2546-0552; ISSN online: 2546-115X)
Vol. 8, pp. 2536-2549
doi: 10.25147/ijcsr.2017.001.1.174
https://stepacademic.net

Short Paper

The Implementation of Augmented Reality on the Internet of Things for Virtual Learning in Higher Education

Oluwasegun Julius Aroba

Honorary Research Associate, Post-Doctoral Research Fellow, Department of Operations and Quality Management, Faculty of Management Sciences, Durban University of Technology, 4000, Durban South Africa
Oluwaseguna@dut.ac.za, aroseglinks@yahoo.co.uk
ORCID: 0000-0002-3693-7255

Date received: October 30, 2023
Date received in revised form: January 2, 2024
Date accepted: January 2, 2024

Recommended citation:

Aroba, O. J. (2024). The implementation of augmented reality on the Internet of Things for virtual learning in higher education. *International Journal of Computing Sciences Research*, *8*, 2536-2549. https://dx.doi.org/10.25147/ijcsr.2017.001.1.174

Abstract

Purpose – This article investigates the potential of augmented reality (AR) for virtual learning in higher education. This review discusses the advantages as well as disadvantages of virtual learning, as well as the advantages and functions of augmented reality in digital literacy on innovative education. With the launch of electronic literacy about two years ago during the COVID-19 epidemic, considerable changes in literacy and tuition methods in higher education have previously occurred. It has become clear that virtual literacy issues are far worse than actual literacy issues. To meet the needs of today's scholars and establish novel tutoring approaches, educational institutions must implement new literacy technology, such as augmented reality. By implementing nascent literacy technology, this investigation hopes to lead to a better comprehension of stoked reality in virtual literacy for advanced education researchers.

Method – The goal of this essay is to investigate the use of augmented reality in higher education for virtual learning. The moderate category of this technology will also be investigated. Head-mounted displays are occasionally used in conjunction with real-world

environments or props, such as when simulating takeoff on a motion platform; however, augmented reality makes reading and teaching methods far more accessible.

Results – Similarly, a use case was created to demonstrate the student journey using stoked reality software on the mobile device to fantasize, comprehend, and make learning more accessible for students to engage with their environment.

Conclusion – Augmented reality has the potential to identify educational surroundings as far more accurate, acceptable, more unifying than digital illiteracy. Increased reality technology affects literacy and the higher education system. It possesses the possibility of increasing the approachability and accessibility of literacy sources in team and personal study.

Recommendations – To successfully integrate augmented reality into the Internet of Things for virtual learning in higher education, organizations need to put a high priority on staff development, make significant infrastructure investments, and foster cross-disciplinary collaboration.

Practical Implications – Higher education institutions should prioritize data security and ethical issues while simultaneously investing in faculty development and AR-IoT infrastructure.

Keywords – electronic literacy, virtual learning environment, augmented reality in education, scope quality effort risk timing, higher education

INTRODUCTION

The modern world is impossible to imagine without digital technologies that permeate all spheres of human activity, specifically in education. Modern students are young people who belong to Generation Z, and thus, many students require digital visual reproduction to understand the educational material. To strengthen the educational process in Higher Education Institutions (HEI), it is essential to increase students' enthusiasm and interest in using modern teaching aids (Gurenvych et al., 2021).

When the COVID-19 pandemic struck, about two years ago, virtual learning was introduced. It became a new normal way for lecturers and students to teach and attend class via MS Teams or other platforms without any experience navigating the virtual learning environment. So according to Tabiri et al. (2022), various challenges or responsibilities are related to the application of comparable knowledge and training. Digital learning challenges are substantially more severe than face-to-face learning problems, such as abstract untruthfulness, condensed common aspects of learning, a lack of applied sensorimotor correlations, complications sustaining scholars' contemplation,

and technical limiting preparation (Nasaenbergs, Ormanis, and Mednis 2020; Aroba et al., 2023). University students grow fatigued with MS Teams classes while being obliged to stare at a single platform for a lengthy period (Blake et al 2024). Various scholars lament that poor internet access poses a significant challenge for fledgling states. The financial system has stayed not capable of providing streamlined or continuous amounts of electricity to all areas of the nation, and where captivity is a favored relatively uncommon preprocess, recruits have access to the online platform and are intellectual to sustain their university degrees proficiently, the completely unbiased of obtaining academics into enhanced academic achievement to emerge projects at with their string as a result of separated spaces is difficult (Nasaenbergs, Ormanis and Mednis 2020, Surkhali 2020).

Smartphones are now an integral part of undergraduate and remote education. As an outcome, even if learning is done face-to-face again, it is impossible to distinguish smartphones from curriculum nowadays, being one of the potential advantages that enable the surroundings to be captivating, and all those smartphones can be used for portraying the real world to feel connected to reality or it can be implausible, designing expertise unsurpassed by existence. When simulating flight on a motion platform, head-mounted displays are sometimes utilized in conjunction with practical settings or actuators. This is because expert's usage of smartphones has evolved into a collective habitation at this theme (Abdullah, Rochmadi, and Wijaya 2022; Tabiri, Fenyi, and Asunka 2022). According to Gurevych et al., (2021) the use of augmented reality technology can boost the productivity of a mobile-oriented educational environment.

LITERATURE REVIEW

Virtual Reality (VR) and Augmented Reality (AR) have the possibility of revolutionizing education. Enriched learning scenarios that allow students to engage with simulated objects and environments can be created using VR. AR can give students real-time feedback and allow them to engage with virtual items in the real world (Aroba et al., 2023b). VR and AR can increase student retention and help them learn more efficiently. As seen in Tables 1 and 2 Platforms I and II, roughly half of the participants discussed the benefits and limitations of augmented reality in education.

Table 1. Platform I

Benefits	Authors
E-learning enables considerably higher versatile information techniques that need vastly less effort.	Al Rawashdeh et al.(2021)
Students can participate actively from any position with any gadget such as a laptop or smartphone.	Surkhali (2020)
AR learning can be more engaging and lifelike than regular classroom sessions.	Farsi et al. (2022)
AR can provide a variety of opportunities and analyses.	Martha et al. (2021)
E-learning is indeed very customizable and can aid student announcements through both asynchronous and asynchronous technology.	Coman et al. (2020)
Virtual learning will assist students develop their computer skills and prepare them to begin working.	Ayu (2020)
AR can be utilized to provide personalized learning experiences that are tuned to each student's immediate requirements.	Aldulaimi and Abdelldayem (2021)
AR enables learners to engage with virtual items in a real-world situation, making the formative opportunity more tangible given that it is close by and malleable.	Faize and Nawaz (2020); Fagbola et al. (2022)

Table 2. Platform II

Pitfalls	Authors
AR technology is still in its infancy and is prohibitively pricey.	Nguyen and Duong (2021)
Students are regularly belated for sessions amid their class lectures.	Dung (2020)
There is a lack of interaction in the virtual learning scenario since collaboration is significantly less crucial than peer tutoring.	Al Rawashdeh et al. (2021)
Technology is costly and necessitates sophisticated instruments.	Surkhali (2020)
Connectivity issues plague virtual learning.	Al Rawashdeh et al. (2021)
Displeasure with virtual classrooms stems from a lack of connection and contact in the digital world.	Nasir and Ngah (2022)
Delayed reaction or support since teachers are not always reachable when students need guidance while studying.	Coman et al. (2020)
As in the e-learning classification, students are assessed as lonely.	Aldulaimi et al. (2021)

MATERIALS AND METHODS

The data gathering material's four steps are depicted. The pertinent records were discovered in the initial stage by utilizing a Web of Science search query (Identification). The extension and prohibition principles were adopted as a result of the novel search results managing a huge number of pamphlets (Screening). The search was restricted to journal papers mainly. There were no language or regional restrictions. The language filter was inoperable because the Web of Science provides reference information (author, title, and conceptual) in English due to idiom modifications and also because authorship studies typically employ data at the abstract level. Brief editorials, errata, surveys, observations, letters, and conference reviews were deleted because they were not properly cited. These factors aided in the deletion of 153 occurrences. To fill the gap

revealed in the review of the literature, we employ the SQERT Model. It enables us to investigate five primary project constraints (Singh et al., 2019; Aroba et al., 2023c).

Scope

The scope of a task is the range of targets, objectives, and procedures necessary to accomplish it. With us main research objective is to develop a method that would enable students to navigate and connect with augmented reality at whichever time and from anywhere. This strategy will be based on a smartphone application through which the students attending a particular course will be directly engaged with education. Students will sign in and will be brought to the homepage, where they will review and adhere to the instructions alongside regular teaching. Students will indeed be encouraged to hit the (MULA) icon, which will take them to a site where they can determine their advancement for engaging with the ordinal internet as well as developing studying existence and lifelong. Several goals are available, according to Tuli and Mantri (2021), such as defining the means of the ability for augmented reality and designing an AR learning environment for students based on the discovered usability principles.

Quality

The compatibility of the application for such a required purpose determines its excellence. The program's purpose is to address the requirements of the stakeholders, which are students, professors, and universities in this scenario. Learners shall engage in various studies using the intended system to keep their studying even if they are not in classrooms. The system was created to encourage students to explore learning regardless regard towards time limits; students enrolling in classes influenced by this structure must bear full responsibility. Likewise, professors will indeed be given orders regarding how to utilize the system in their classes, and they will be in charge of leading their pupils to guarantee that everyone utilizes the system. The upcoming system will enable speakers to build connections in academics, which will enhance student meetings. Though the system cannot be used by all faculty and students who do not hold academic permission, it has to become legal before it can be used.

Effort

Work revenue is utilized to attain project objectives through hard work. GPS and a sensor must be applied continuously to grow augmented reality.

Risk

It is the effect of the transformation that increases full accessibility. As just a consequence, augmented reality systems may observe what the controller is accountable for or even collect a substantial amount of information about who the operator is and the

activities they are doing, putting the user's confidentiality in jeopardy. Augmented reality subjects become more troublesome whenever the person utilizes VR glasses or Intelligent Glasses rather than using their phone camera viewfinder. Excessive use of AR features during a call can result in aesthetic tension for such an operator, causing symptoms such as disorientation or uneasiness.

Time

Outcomes need to be provided. Thus, according to our estimates, producing an augmented reality application can require 3 months, based on the complexity of the application.

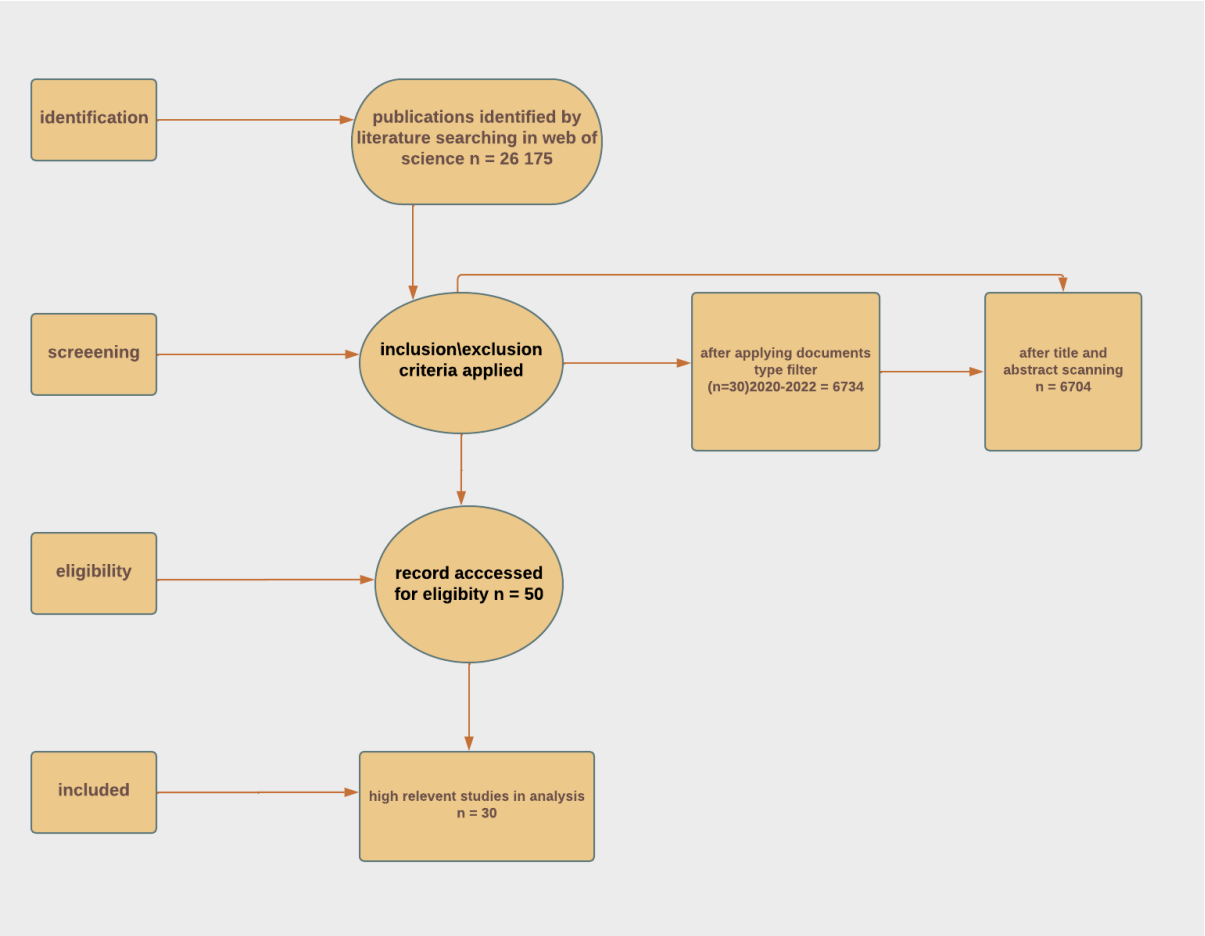

Figure 1. Flow Process of Extraction and Segregation Procedures (Aroba 2024 Own's Construct)

Figure 1 shows four component flowcharts of both the data extraction and segregation procedure.

RESULTS

Augmented Reality (AR) and Virtual Reality (VR) Interactions

Based on the facts in the graph below, we may assume that there will be fluctuations between both actual as well as digital information here between periods (2020 and 2022). It is unknown whether substantial technical progress in this technology has occurred before 2020. Throughout the first two years, no progress was accomplished (2018-2019). Whenever the COVID-19 outbreak began in 2020, there was a considerable inflow. Many higher education organizations have moved from traditional to distance courses.

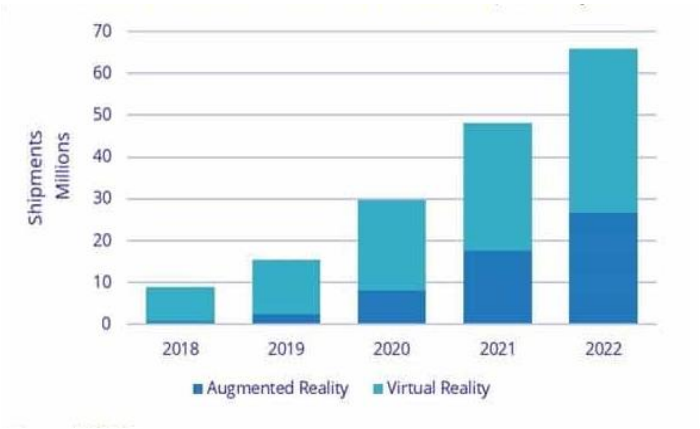

Figure 2. Augmented Reality and Virtual Reality (Alzahrani 2020)

Figure 2 shows the movement from 2018 to 2022 in VR and AR publishing and referencing.

AR and VR with a High Pitch

The graph above confirms the quick rate of expansion from (2018-2022) and reveals that this began in 2020 when the prevalence of virtual reality (VR) and augmented reality (AR) in abstract journals progressively rose over the prior years. It should be highlighted that the growth is predictable from 2020 when the COVID-19 tendency started.

Figure 3 depicts a person interacting with AR technology in a smartphone application, illustrating that once a user is participating in the enhanced reality content, it becomes available elsewhere. Figure 4 is one of the examples of pupils in a relevant subject course who transit more through the systemic circulation.

Figure 3. Augmented Reality Display Lu et al. (2021)

Figure 4. Sample of Systemic Circulation (Enzani et al. 2021)

Advantages of Augmented Reality

According to Alzahrani (2020), a capacity of 3D visual representations in instructing food sense of touch reading skills by developing a unification numeracy plan that allows scholars to comprehend and be gratified by detailed 3D issues in academics studying effectively and quickly, especially in eluent relation to academic such as physics and chemistry. Stoked reality is helpful in the laboratory because it enables novel, well-organized portrayal of intangible sundries, which raises student participation and comprehension demands. The rewards of visual analysis are facilitated by hyped truth in developing the student's comprehension of and fixing real-world problems; educators can more seamlessly appreciate tender ideas in literacy due to super psyched

humankind's extraordinary potential to envision examples and intimate data (Lu et al. 2021). The learner can engage with virtual objects presented to them by employing augmented reality (Enzani et al. 2021). According to Nasenbergs et al, (2020), results, an augmented reality system is a more effective means of vocabulary acquisition than memorization. Students can benefit from AR's capacity to lessen interruption. Augmented reality may transform 2D photos into virtual 3D objects with object motion, enhancing their appeal and entertainment (Elfelky and Elbvaly 2021).

CONCLUSIONS

A revolutionary step towards the future of education is the integration of augmented reality (AR) into the Internet of Things (IoT) architecture for virtual learning in higher education. This potent convergence of technology not only improves the educational experience but also solves several issues that confront universities. Students now have access to immersive, interactive learning environments that stimulate their senses and promote deeper knowledge thanks to the convergence of AR and IoT. It encourages hands-on learning, applying knowledge in practical settings, and developing the essential skills required for the workforce of the twenty-first century. Additionally, a wider range of people may access high-quality education thanks to the scalability and flexibility of AR-IoT systems, which close socioeconomic and geographic divides. It can completely transform instructional strategies, departing from conventional pedagogies and empowering teachers and students alike.

But as this technological revolution takes shape, issues with price, accessibility, and data security must be addressed. It is critical to guarantee fair access to AR-IoT-enhanced education and to protect sensitive data. To fully integrate augmented reality (AR) into the Internet of Things (IoT) for virtual learning, cooperation between academic institutions, IT companies, and legislators is essential. Together, they have the power to create a future in which learning takes place in virtual spaces rather than in traditional classrooms, providing students with a wide range of opportunities to develop their critical thinking, creativity, and sense of global connectedness.

All things considered, the integration of augmented reality with the Internet of Things holds promise for changing the face of higher education by bringing it into the modern era and making it more dynamic, inclusive, and adaptable to the changing requirements of students. We are starting a journey towards a future where education has no bounds and pursuing knowledge is an engaging and transforming experience as we accept this powerful paradigm shift. Augmented reality has the potential to identify educational surroundings as far more accurate, acceptable, more unifying than digital illiteracy. Increased reality technology affects literacy and the higher education system. It possesses the possibility of increasing the approachability and accessibility of literacy sources in team and personal study. Virtual literacy supports all stages since it combines scholars and speakers. Enforcing virtual literacy was crucial to converting a result and keeping schooling going. Although understand how it tests scholars, we have second

thoughts. Virtual literacy will generate inept graduates; they will always pass, but it does not imply they know anything because they are capable of deception. As a result, graduates from virtual schools will lack data literacy. Considering synthetic reality is a blend of virtual and real worlds, we advocate mandating it in all institutions of higher education. It provides an interactive literate environment and enables you to exercise your abilities and understanding in real-world circumstances; eventually, it produces commercially qualified professionals with vivid chops that may be applied to any position in the sector. A stoked reality in teaching could be more accurate for little events and objects that are challenging to observe with the eyes.

RECOMMENDATION

The higher education should also emphasize data security, provide equal access, and participate in ongoing evaluation and development. Furthermore, promoting international cooperation, incorporating students in content production, and pushing for supportive regulations are necessary for a thorough and successful integration. These suggestions will open the door to a virtual learning environment that is inclusive and transformative.

IMPLICATIONS

According to the research, augmented reality combined with the Internet of Things has the potential to completely transform higher education by providing students with immersive, engaging, and powerful learning experiences. According to the findings of the study, to fully utilize the educational benefits of AR-IoT technology, higher education institutions should prioritize data security and ethical issues while simultaneously investing in faculty development and AR-IoT infrastructure. The ramifications highlight the necessity of further investigation and cooperation to enhance the application of augmented reality in Internet of Things-based virtual education, guaranteeing its sustained expansion and efficiency in educating students for the digital era.

ACKNOWLEDGEMENT

This research was funded by Durban University of Technology.

FUNDING

This research was funded by Durban University of Technology.

DECLARATIONS

The author declares no conflict of interest or financial or personal relationships that may have inappropriately influenced him in writing this article.

Conflict of Interest

The researcher declares no conflict of interest in this study.

Informed Consent

Not applicable

Ethics Approval

The article followed all ethical standards for research with direct contact with human or animal subjects.

REFERENCES

Al Rawashdeh, A. Z., Mohammed, E. Y., Al Arab, A. R., Alara, M., & Al-Rawashdeh, B. (2021). Advantages and disadvantages of using e-learning in university education: Analyzing students' perspectives. *Electronic Journal of E-learning*, *19*(3), 107-117.

Aldulaimi, S. H., Abdeldayem, M. M., Keir, M. A., & Al-Sanjary, O. (2021). E-learning in higher education and COVID-19 outbreak: Challenges and opportunities. *Psychology and Education Journal*, *58*(2), 38-43.

Abdullah, A. A., Richardo, R., Rochmadi, T., Wijaya, A., & Nurkhamid, N. (2022). The Use of Ethnomathematics Learning Media Based on Augmented Reality for Madrasah Students. *AL-ISHLAH: Jurnal Pendidikan*, *14*(1), 877-886.

Alzahrani, N. M. (2020). Augmented reality: A systematic review of its benefits and challenges in e-learning contexts. Applied Sciences, 10(16), 5660.

Aroba, O. J., Chisita, C. T., Buthelezi, N., & Mthethwa, N. (2023). Higher education enterprise resource planning system transformation of supply chain management processes. In *International Congress on Information and Communication Technology* (pp. 415-424). Singapore: Springer Nature Singapore.

Aroba, O. J., Xulu, T., Msani, N. N., Mohlakoana, T. T., Ndlovu, E. E., & Mthethwa, S. M. (2023, March). The adoption of an intelligent waste collection system in a smart city. In 2023 Conference on Information Communications Technology and Society (ICTAS) (pp. 1-6). IEEE.

Aroba, O. J., Mabuza, P., Mabaso, A., & Sibisi, P. (2023, January). Adoption of Smart Traffic System to Reduce Traffic Congestion in a Smart City. In *International Conference on Digital Technologies and Applications* (pp. 822-832). Cham: Springer Nature Switzerland.

Ayu, M. (2020). Online learning: Leading e-learning at higher education. *The Journal of English Literacy Education: The Teaching and Learning of English as a Foreign Language*, *7*(1), 47-54.

Blake, R., Jones, L., & Osburn, C. (2024). Hybrid and online teaching and flipped classroom. In *La enseñanza del español mediada por tecnología* (pp. 247-266). Routledge.

Coman, C., Țîru, L. G., Meseșan-Schmitz, L., Stanciu, C., & Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: Students' perspective. *Sustainability*, *12*(24), 10367.

Dung, D. T. H. (2020). The advantages and disadvantages of virtual learning. *IOSR Journal of* Research & *Method in Education*, *10*(3), 45-48.

Elfeky, A. I. M., & Elbyaly, M. Y. H. (2021). Developing skills of fashion design by augmented reality technology in higher education. *Interactive Learning Environments*, *29*(1), 17-32.

Enzai, N. I. M., Ahmad, N., Ghani, M. A. H. A., Rais, S. S., & Mohamed, S. (2021). Development of augmented reality (AR) for innovative teaching and learning in engineering education. *Asian Journal of University Education*, *16*(4), 99-108.

Faize, F. A., & Nawaz, M. (2020). Evaluation and improvement of students' satisfaction in online learning during COVID-19. *Open praxis*, *12*(4), 495-507.

Fagbola, T. M., Fagbola, F. I., Aroba, O. J., Doshi, R., Hiran, K. K., & Thakur, S. C. (2022). Smart Face Masks for Covid-19 Pandemic Management: A Concise Review of Emerging Architectures, Challenges and Future Research Directions. *IEEE Sensors Journal*.

Farsi, Z.A., E.; Fournier, A.; Ahmadi, Y.; Sajadi, S. A.; Aliyari, S. (2022), Investigating Nursing Student' Satisfaction with the Quality of Courses and Virtual Learning During the Covid-19 Pandemic in 2020-2021. *Turkish Online Journal of Distance Education*, *23*(3), 103-117.

Gurevych, R., Silveistr, A., Mokliuk, M., Shaposhnikova, I., Gordiichuk, G., & Saiapina, S. (2021). Using augmented reality technology in higher education institutions. *Postmodern Openings*, *12*(2), 109-132.

Lu, A., Wong, C. S., Cheung, R. Y., & Im, T. S. (2021, April). Supporting flipped and gamified learning with augmented reality in higher education. In *Frontiers in education* (Vol. 6, p. 623745). Frontiers Media SA.

Martha, A. S. D., Junus, K., Santoso, H. B., & Suhartanto, H. (2021). Assessing undergraduate students' e-learning competencies: A case study of higher education context in Indonesia. *Education Sciences*, *11*(4), 189.

Nasir, M. K. M., & Ngah, A. H. (2022). The sustainability of a Community of Inquiry in online course satisfaction in virtual learning environments in higher education. *Sustainability*, *14*(15), 9633.

Nesenbergs, K., Abolins, V., Ormanis, J., & Mednis, A. (2020). Use of Augmented and Virtual Reality in Remote Higher Education: A Systematic Umbrella Review. Educ. Sci. 2021, 11, 8.

Nguyen, H. U. N., & Duong, L. N. T. (2021). The challenges of e-learning through Microsoft Teams for EFL students at Van Lang University in COVID-19. *AsiaCALL Online Journal*, *12*(4), 18-29.

Singh, V. K., Callupe, S. P., & Govindarasu, M. (2019, October). Testbed-based evaluation of Siem tool for cyber kill chain model in power grid SCADA system. In *2019 North American Power Symposium (NAPS)* (pp. 1-6). IEEE.

Surkhali, B., & Garbuja, C. K. (2020). Virtual learning during COVID-19 pandemic: pros and cons. *Journal of Lumbini Medical College*, *8*(1), 154-155.

Tabiri, M. O., Jones-Mensah, I., Fenyi, D. A., & Asunka, S. (2022). Challenges of online learning of English/French language in higher education in Ghana. *Journal of Language and Linguistic Studies*, *18*(1), 207-222.

Tuli, N., & Mantri, A. (2021). Evaluating usability of mobile-based augmented reality learning environments for early childhood. *International Journal of Human–Computer Interaction*, *37*(9), 815-827.

Author's Biography

Oluwasegun. J. Aroba, a Durban University of Technology, Department of Information Systems. Honorable Research Associate in the Department of Operations and Quality Management. He has a Ph.D. in Information Technology. A well-known author researcher, and business magnate, who has published over 20 Journal articles that are the heart of information technology research. A graduate of Information Technology University from the prestigious Coventry University United Kingdom, BSc. Computer Science and Technology (Upper-Class Division) Crawford University whose research inclination focus area are into Wireless Sensor Networks, Hyper-Heuristic, Artificial Intelligence, Meta-Analysis, Project Management, Data Science, Machine Learning, SAP Specialist with over a decade years of experience in the higher education sector, healthcare industries, government parastatals, a consultant across the globe, a graduate member of IEEE, IITPSA South Africa, Member of IET UK. He has Chaired and Co-Chaired International and National Conferences. He is a global mentor to SMEs and European African, Sisonke NdabaX, and a seasoned guest speaker at IndabaX South Africa. He has a vast collaboration network across Spain, France, Morocco, the USA, the UK, South Africa, and Sweden. oluwaseguna@dut.ac.za, aroseglinks@yahoo.co.uk .

Google Scholar URL: https://scholar.google.com/citations?user=4pn2PsMAAAAJ&hl=en&authuser=1&oi=ao

ORCID URL: https://orcid.org/0000-0002-3693-7255

SCOPUS URL ID: https://www.scopus.com/authid/detail.uri?authorId=57222245129

LinkedIn URL: https://www.linkedin.com/in/julius-o-aroba-ph-d-83409150/

Web of Science URL: https://www.webofscience.com/wos/author/record/ABD-6251-2021?state=%7B%7D , Web of Science Researcher ID: ABD-6251-2021

Linktr.ee URL: https://linktr.ee/aroseglinks

Research Gate: https://www.researchgate.net/profile/Oluwasegun-Aroba