Arab World English Journal
INTERNATIONAL PEER REVIEWED JOURNAL ISSN: 2229-9327

Arab World English Journal (AWEJ) Volume 16. Number 4, December 2025 Pp.185-195
DOI: https://dx.doi.org/10.24093/awej/vol16no4.10

# Unlocking the Potential of AI-Enhanced Mixed Reality: Enhancing Technical English Proficiency for Engineering Students in the Gulf Region

**Shafiq ur Rehman**
Foundation Program Unit, University of Doha for Science and Technology, Qatar.
Corresponding Author: shafiqur.rehman@udst.edu.qa

**Rabia Khatoon**
English Language Institute, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia
Email: rkkhan@kau.edu.sa

**Intakhab Alam Khan**
King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia
Email: ikhan1@kau.edu.sa

Received: 08/29/2025 Accepted: 11/5/2025 Published: 12/10/2025

**Abstract**
This study examines the influence of artificial intelligence (AI) augmented mixed reality (MR) technologies on the enhancement of technical English proficiency among engineering students in the Gulf countries. The main aim of the research is to explore how the gap between foreign language learning and domain-specific technical knowledge can be reduced by integrating the immersive and adaptive MR environments with AI. The mixed method design was used to evaluate the effectiveness of AI-enhanced MR technologies in a 12-week course. The sample size consists of 300 students from the Gulf region. The treatment group used AI-enhanced MR technologies, which simulated real-life engineering scenarios to facilitate content-based English learning. The quantitative data from the pre-and post-tests revealed higher proficiency with the mean score of 72.5 to 80.3 that shows a medium-to-large statistically significant improvement. The qualitative data indicated enhanced engagement, confidence, and understanding of technical vocabulary. The study's results suggest that AI-driven MR applications provide an practical pedagogical approach for advancing English for Specific Purposes (ESP), particularly within a Science, Technology, Engineering, and Mathematics (STEM) setting. Technical issues, usability problems, and misalignment with culture were highlighted as challenges. Improving the technical support and cultural appropriateness of the content would address these challenges. The study's significance is shown through its contribution to practical pedagogical strategies by combining AI and MR for ESP instruction in the engineering context. It also reflects that these technologies can be effective in other fields.

***Keywords*:** Artificial intelligence, engineering, English for specific purposes, English proficiency, Gulf countries, human-computer interaction, immersive learning environments, mixed reality
**How to cite:** Rehman, S.U., Khatoon, R., & Khan, I.A. (2025). Unlocking the Potential of AI-Enhanced Mixed Reality: Enhancing Technical English Proficiency for Engineering Students in the Gulf Region. *Arab World English Journal, 16*(4): 185-195.
https://dx.doi.org/10.24093/awej/vol16no4.10

## Introduction

Teaching English, primarily in an English for Specific Purposes (ESP) context, has become easier than ever because of the integration of artificial intelligence (AI)-enhanced and mixed reality (MR) technologies, which are known for their innovative and interactive nature. It helps students in the Gulf countries to deal with their two major issues of improving their English proficiency and comprehending the complex disciplinary content by providing integrated solutions that combine immersive, adaptive, and interactive learning experiences. AI-driven tools personalize and tailor content delivery, adapting to individual learners' needs, enhancing comprehension, retention, and engagement. For instance, AI can evaluate dynamic ways of understanding, and it changes instructional materials to meet the needs, applicable mainly in technical areas in which students need to understand more of the terminology and concepts (Ai, 2024).

MR, based on augmented reality (AR) and virtual reality (VR), provides an immersive environment that helps enhance learning results. MR allows for the simulation of engineering scenarios, preparing students to practice and apply technical English within an authentic context. This dual functionality supports both language acquisition and subject-specific understanding, aligning with the cognitive demands of engineering education (Ai, 2024). This has been noticed from multiple studies that AI-enhanced MR technologies support vocabulary acquisition, particularly when used in ESP settings (Divekar et al., 2021). However, the use of AI and MR is under-researched in the Gulf region for teaching English to engineering students. The available studies mainly discuss the general English proficiency and technological adoption, but present little findings on the contextual need of technical communication. Therefore, the current study aims to answer the following research questions:

- What is the effectiveness of AI-enhanced MR technologies in enhancing technical English proficiency in engineering students in the Gulf region?
- What are the specific challenges and benefits of using AI-enhanced MR for teaching technical English in engineering contexts?
- To what extent do AI-enhanced MR technologies influence students' human-technology interaction skills to understand and apply technical English in practical scenarios?

## Literature Review

The phenomenon of AI and MR has received increasing attention in educational research, particularly in language teaching acquisition and technical education. This literature review provides an overview of current research on the effect of AI-enabled MR technology on the technical English proficiency of engineering students in the Gulf Region (Chen et al., 2021; Strielkowski et al., 2023; Yannier et al., 2024).

Several studies have demonstrated how AI-MR integration supports second- or foreign-language learners and enhances retention, motivation, and engagement. For example, AlSaleem (2023) and Khodabandeh et al. (2025) show that augmented reality (AR) and AI-enhanced MR can significantly enhance vocabulary teaching and learning in the ESP contexts. Further research shows that AI-enhanced MR applications are excellent tools to merge AI with MR, fostering both language development and content mastery (Celik & Kara, 2024). Such applications, which simulate authenticity and domain-specific experiences and tasks where language use is naturally embedded, align with Content-Based Instruction (CBI) and ESP principles.

AI-enabled MR settings can create the effect of interactive classrooms where personalized learning is delivered that adapts to the pace and needs of the student. During engineering and

medical education, the integration of MR with AI can assist in developing models for complex procedures, which may be helpful for students to practice in real-life scenarios with instant feedback (Syahrin & Akmal, 2024). The studies from engineering, medical surgeries, fashion, and retail industries (Aljuaid, 2024; Gil-López et al., 2023; Hemphill et al., 2021; Kim, 2023; Kumar et al., 2022; Luan et al., 2020; Taşdemir et al., 2025) show how these technologies can be used to improve efficiency and effectiveness.

This study is guided by theoretical frameworks, including Cognitive Load Theory (CLT) and Social Constructivism. It shows how an AI-enhanced MR model can be integrated in pedagogy to support students in understanding of the complex educational challenges they face. A study by Divekar et al. (2021) has used a similar kind of model focusing on the importance of personalized, immersive, and culturally appropriate design to support language learning in authentic contexts. Yannier et al. (2024) further support that these tools can be practical for providing students with adaptive feedback and scaffolding complex tasks. The Cognitive Load Theory (CLT) states that the use of instructional design load should be minimized on the learners so that the learns can focus their working memory on core learning tasks. As Van Nooijen et al. (2024) explain, "Scaffolding regulates the flow of information within the learner's working memory, thereby reducing cognitive load" (p. 1). AI-enhanced MR environments reduce this load (Yannier et al., 2024). Moreover, Social Constructivism theory supports the pedagogical rationale of the study, as it focuses on learning as a socially mediated activity, where interaction and collaboration drive knowledge construction. The research also addresses broader educational goals, including improved engagement, adaptation to regional educational needs, and fostering human-technology interaction. Aguayo and Eames (2023) justify the collaborative learning principles of the MR environment by arguing that learning among learners is because of socially mediated interactions: "students, educators, and parent helpers were involved in spontaneous learning interactions during the immersive snorkeling and visitor center experiences" (p. 69).

## Methodology

### *Research Design*

The convergent mixed-methods design of research was used by combining both the quantitative and the qualitative methodologies as suggested by Creswell & Plano Clark (2017). The learner's performances were gauged by using pre-and post-tests in the quantitative part. To explore students' learning experiences, their engagement, and contextual factors, the study used interviews, surveys, and classroom observations.

### *Population*

The target population for this study is the undergraduate and postgraduate engineering students from universities in the Gulf region. A purposive stratified sampling strategy was used to ensure proportional representation from each country and academic level. The final sample of 300 participants was distributed approximately equally across the countries and disciplines. The following calculation shows the validity of the selected sample from the Gulf countries. It was calculated using the population estimate of approximately 102,000 engineering students across the Gulf region, at a 95% confidence level and a 5% margin of error. The recommended sample size was 383 students. The following sample size formula is used for the population:

$$n = \frac{N \times Z^2 \times p \times (1-p)}{E^2 \times (N-1) \times Z^2 \times p \times (1-p)}$$

Substituting the values:

$$n = \frac{102000 \times (1.96)^2 \times 0.5 \times (1-0.5)}{(0.05)^2 \times (102000-1) + (1.96)^2 \times 0.5 \times (1-0.5)} \approx 383$$

***Instruments***

Table 1 provides an overview of each instrument and data collection.

Table 1. *Instrumental details*

| Instrument | Description | Purpose | Data Type |
|---|---|---|---|
| Standardized Tests | Pre- and post-tests to measure ESP proficiency. | Assess pre-and post-improvement in language proficiency | Quantitative |
| Surveys | Questionnaires include Likert-scale items and open-ended questions. | Capture students' perceptions, challenges, benefits, and satisfaction. | Quantitative and Qualitative |
| Semi-Structured Interviews | One-on-one interviews | Investigate human-technology interaction | Qualitative |
| Classroom Observations | Real-time observations of AI-enhanced MR integration in classrooms. | Evaluate student engagement, participation, and learning dynamics. | Qualitative |

***Data Collection Methods***

The researchers used research assistants from each of the six countries to collect data. The researchers mandated these assistants to organize, follow up with various universities, arrange, and facilitate video-conferenced focus group discussions and semi-structured interviews. The rubrics used by them to train faculty focused on critical aspects of classroom dynamics, including student engagement, use of MR technology, and interaction quality. These criteria included the frequency and quality of the student-teacher interactions in the MR settings, integrating technical English, and the effectiveness of the technology in supporting learning outcomes.

***Reliability & Validity Measures***

Unified rubrics were used for the standardized tests developed. The surveys were designed using standard questions and were piloted for validity and clarity by the experts. For the semi-structured interview, the open-ended questions were matched with key aspects of human-technology interaction. Lastly, the calibration sessions were conducted to use the classroom observation rubrics.

***AI-Enhanced MR Curriculum Module for Technical English in Engineering***

Each teaching session integrated AI-powered features to personalize the MR experience and lasted for 90 minutes a week. The AI algorithms analyzed students' interactions, provided real-time corrections to their language use, and adjusted task difficulty. First week, reviewed the course objectives and technology tutorial. Secondly, basic engineering-related terminologies were introduced during this module. The second module, during weeks two and four, focused on terminology related to core engineering disciplines. Additionally, MR was introduced to visualize the engineering processes. The third module, during weeks five and seven, focused on materials science and engineering methodologies. Moreover, MR activities were performed interactively on material properties and testing procedures. The fourth module during weeks 8 and 10 covered

research on engineering systems, i.e., HVAC or electrical grids. It also integrated MR exercises for building or repairing systems. The fifth module during week 11 focused on health, safety, and environmental standards. In the last module, the students prepared a small project to describe one engineering solution using technical English. Lastly, peer and instructor feedback were provided through MR-enabled sessions.

## Results

### *Pre-and Post-test Quantitative Data*

To evaluate the effectiveness of AI-enhanced MR technologies in improving technical English proficiency, standardized technical English proficiency tests were administered before and after using AI-enhanced MR technologies. Pre- and post-test scores were analyzed by a paired t-test to evaluate significant differences and help decide on effectiveness. Table 2 below elaborates on the descriptive statistics for the pre- and post-test scores.

Table 2. *Pre-and post-test results*

| Metric | Pre-Test Mean | Post-Test Mean | Change in Mean |
|---|---|---|---|
| Overall | 72.5 | 80.3 | +7.8 |
| Saudi Arabia | 70.0 | 78.2 | +8.2 |
| UAE | 75.0 | 82.5 | +7.5 |
| Qatar | 73.0 | 81.0 | +8.0 |
| Oman | 71.5 | 79.0 | +7.5 |
| Kuwait | 74.0 | 82.0 | +8.0 |
| Bahrain | 72.0 | 79.5 | +7.5 |

The t-test results showed a significant improvement in scores, with a p-value of 0.001, well below the conventional level of 0.05. This outcome indicates that the intervention effectively enhanced the students' technical English skills and had a positive effect on student outcomes. The effect size for this study was calculated using Cohen's d formula. For instance, with a mean post-test score of 80.3, a pre-test score of 72.5, and a standard deviation of 10, the calculated effect size is $d = \frac{80.3 - 72.5}{10} = 0.78$. This value indicates a medium to large effect size, suggesting AI-enhanced MR intervention significantly improved the technical English proficiency of students.

### *ANOVA result*

Since the data were collected from various Gulf countries, a one-way Analysis of Variance (ANOVA) was conducted to evaluate the degree of improvement. The independent variable was the country of origin. The dependent variable was the test score improvements, calculated as the change in performance from the pre-test to the post-test. The analysis produced an F-value of 2.34 together with a p-value of 0.045. The F-value represents the ratio of variance between the country groups to the variance within those groups. A higher F-value indicates a general likelihood of differences existing between groups. The p-value of 0.045 is lower than the standard alpha threshold of 0.05, which shows that the observed differences in improvement scores reach statistical significance. Figure 1 below presents a boxplot visualization showing the distribution of post-test score variation and central tendency across countries. Each box represents the distribution of scores within a country, showing the median, interquartile range, and outliers.

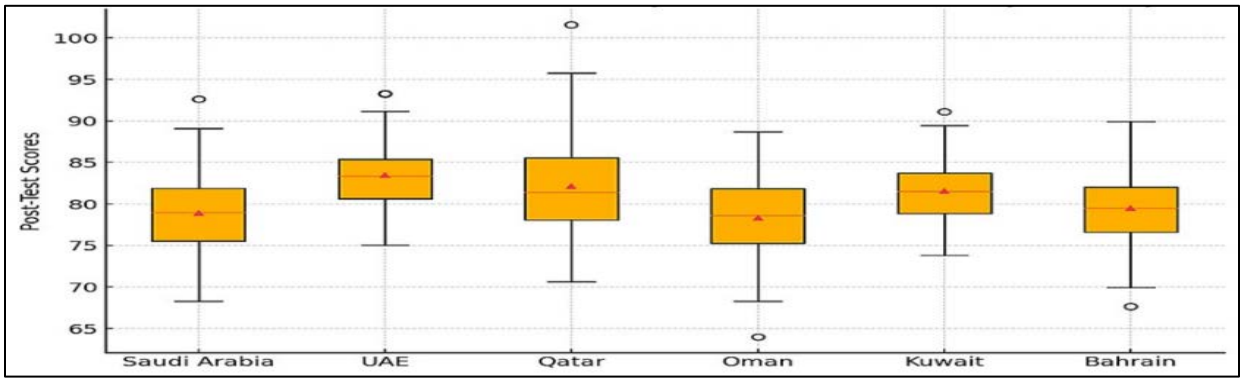



*Figure 1.* Variation and central tendency in post-test scores by country

The ANOVA test showed no significant difference among countries regarding the effectiveness of the AI-enhanced MR technology: F = 1.58 (p = 0.17) for five groups and 377 degrees of freedom. The technology achieved successful results in all educational environments in which it was used.

*Survey Results*

A quantitative survey was conducted to evaluate participants' perceptions of AI-enhanced MR technology. The survey contained four essential constructs, which used a 5-point Likert scale to measure participants' ratings for ease of use, technical English confidence, engagement level, and general satisfaction.

Table 3. *Metrics discussion*

| Metric | Mean Score | Standard Deviation |
|---|---|---|
| Ease of Use | 4.2 | 0.8 |
| Confidence in Technical English | 3.9 | 0.9 |
| Engagement Level | 4.1 | 0.85 |
| Overall Satisfaction | 4.0 | 1.0 |

Descriptive statistics on questionnaire data showed that, on average, students mainly experienced the AI-enhanced MR technology as easy to use, at 4.2. Also, the student's confidence level in technical English post-intervention was, on average, applicable at 3.9. Besides, the technology considerably increased engagement in learning activities, as reflected by an average score of 4.1 out of 5, indicating that students were more involved and active in the learning process with the use of technology. Figure 2 below shows the average survey scores for three essential areas: Ease of Use, Confidence in Technical English, and Engagement in Learning for a 12-week course.

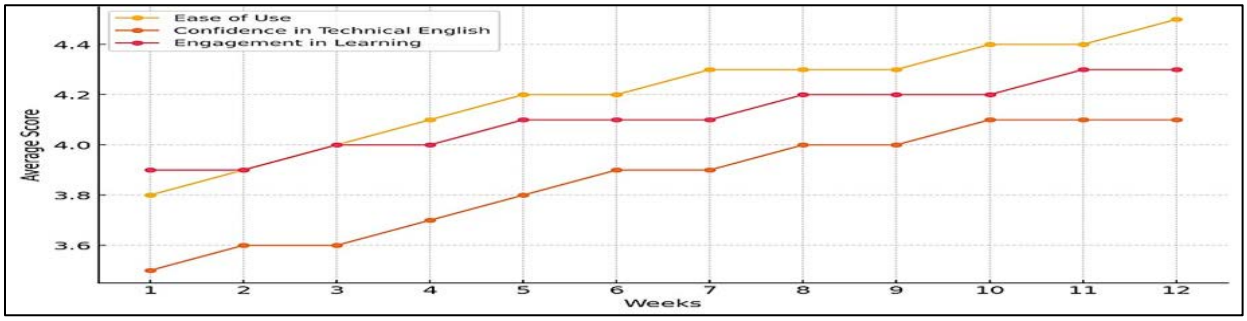



*Figure 2.* Survey scores over time

### *Qualitative Results*

*Thematic Analysis*

The open-ended items in the survey revealed several recurring challenges and perceived benefits of using AI-enhanced MR for technical English instruction. Thematic analysis was conducted following the steps of familiarisation, coding, theme identification, and refinement, as proposed by Braun and Clarke (2006).

*Semi-Structured Interview*

The semi-structured interviews were analyzed to draw inferences from the qualitative data and capture a rich understanding of participants' experiences with AI-enhanced MR technology for learning technical English. Verbatim transcriptions were first created for all interviews, followed by repeated reading to familiarise the researchers with the content and identify emerging patterns.

*Theme Development*

Codes were further aggregated under possible themes reflecting a distinct feature of how the technology appears to aid learning in the engineering context. For "better understanding", some students reported "the visual and interactive nature of the MR environment made technical terms more understandable." For "Application in Real Life", many instructors highlighted "students are not just learning the terms; they are using them in context, which shows real learning progress." For "User Experience and Interaction", some students commented, "The interface is user-friendly most of the time, but because of occasional bugs, the sessions become frustrating." For the "Challenges and Barriers", students commented, "Sometimes the content does not align well with the local context".

*Classroom Observations*

For the classroom observation, multiple factors were considered to see the application of these technologies. It focused on the classroom setting and environment to determine the implementation of AI-enhanced MR technologies. Moreover, it focused on students' participation during their learning process. It was noticed that the classroom setup was appropriate for MR technology, and there were ample supplies for MR when needed in the session. In addition, MR technology was frequently embedded into observed classroom activities, which are constantly or frequently repeated within each lesson. The primary type of application used was subject-related simulations and interactive lectures intended to clarify abstract ideas. Furthermore, the use of MR technologies has resulted in a high level of engagement among the students during individual, group-based, and class-wide activities. The most significant ones were peer-to-peer teaching moments in which students taught one another concepts by using the MR applications' interactive features. Finally, the use of MR technology fulfilled the learning outcomes established for the sessions very successfully, showing significant gains in students' understanding and competency.

## Discussion

### *Discussion on Quantitative Insights*

The findings of this study strongly support the main research questions, which suggest that AI-enhanced MR technologies significantly improve technical English proficiency and that technology-integrated ESP and CBI models are effective in engineering education in the Gulf

region. Additionally, the significant gains in pre- and post-tests, with medium-to-large effect size validate that immersive AI-integrated learning environments can enhance students' language competencies in STEM settings. The results of the study also align with Cognitive Load Theory (CLT) by reducing cognitive overload and supporting dual-channel processing, allowing students to visualize complex engineering concepts (Hong & Guo, 2025). As noted in various other studies (Khodabandeh et al., 2025; Parmaxi & Demetriou, 2020), these models appear to be efficient primarily when there are high scores for usability and satisfaction.

Additionally, the study reports a 0.045 p-value in the ANOVA, which shows that these scores were not the same across the Gulf countries. These findings show the importance of more efficient technological integration and appropriate cultural contexts. The research should determine particular country pairs through post-hoc tests, which include Turkey's Honestly Significant Difference (HSD), to confirm their statistical differences.

The research results show that AI-based MR learning platforms achieve successful outcomes, which work well across different cultural settings for teaching ESP. Additionally, the absence of significant differences in the perceived effectiveness of geographical indicates the universality of the technology-enhanced language learning when properly localized and supported. The research validates CLT principles because student satisfaction depends on usability, which CLT seeks to reduce unnecessary mental work for improved task achievement. The growing learner confidence and participation levels follow CLT principles because students learn language and technology skills by using digital tools in authentic ways.

***Discussion on Qualitative Insights***

The semi-structured interviews, open-ended surveys, and classroom observations produced qualitative data that supported the quantitative results by documenting students' social interactions and their opinions on system usability and the educational value of these technologies. The survey results, interview data, and observational findings show that teachers found AI-enhanced MR environments to be educationally beneficial for teaching technical and STEM subjects. The data sources indicate that MR is a practical tool for teaching content-based language instruction. The students repeatedly mentioned the benefits of the visual and immersive elements of these technologies in making the complex ideas more comprehensible.

The qualitative results showed that learners obtained substantial learning advantages through their work with authentic tasks and peer collaboration, and interactive feedback during their activities. These results align with Social Constructivist theory, which supports the idea that students learn better through social interaction and active engagement with real-world problems. Students applied peer work during MR sessions to build their language skills and concept knowledge through activities, which combined ESP vocabulary for effective learning. The research evidence supports Shaddad and Jember (2024), who demonstrate that students learn language skills by studying educational materials that teach academic content through meaningful interactions and scenarios.

The qualitative data showed that students and instructors faced various technical problems, which involved software failures, hardware problems, and unreliable internet connections. The students encountered cultural differences, which created understanding challenges because their backgrounds did not match. The system needs particular educational modifications at every deployment location before implementation, and system-related problems require staff members who specialize in technical support to overcome these challenges.

## Conclusion

This study investigates the effectiveness of AI-enhanced MR technologies in improving technical English proficiency among engineering students in the Gulf region. A 12-week MR-enhanced curriculum was implemented, where students engaged in context-rich, interactive simulations that combined engineering content with targeted language use. Analysis of pre-and post-test standardized data on the number of significant gains by students in their technical English skills was then validated with paired t-tests and ANOVAs for all groups of participants, native language, and previous experience with MR. Based on Cohen's d, the effect size was medium to large, signifying that the MR technologies practically amplified students' understanding and use of technical English within engineering contexts. The class observations showed a relatively high level of engagement and practical application of concepts learned in MR sessions. Qualitative data revealed that students' and instructors' reception of MR technology was favorable, as the immersive and interactive nature of the MR environment facilitated deeper conceptual understanding and improved communicative competence. Nevertheless, the study also identified several difficulties, such as technical problems, a steep learning curve, and limited cultural contextualization in the MR scenarios. The study suggested more culturally relevant content and better technical support. It concluded that AI-enhanced MR technologies represent a promising instructional tool for English for Specific Purposes (ESP) contexts, especially in STEM education. The study has implications for other disciplines where effective communication is also essential. Future research and development need to be in place to update such educational tools and address identified challenges with wider adoption in global education. Finally, ongoing research and development are key to optimizing AI-MR platforms, ensuring they remain pedagogically sound, technologically reliable, and inclusive across diverse educational settings.

**Funding:** This research is not funded.

**Acknowledgment**: Not applicable.

**Conflict of Interest**: The authors declare no conflict of interest.

**Authenticity:** This manuscript is an original work.

**Artificial Intelligence Statement:** During the preparation of this work, the authors used ChatGPT, Grammarly, and Keenious in order to proofread, improve readability, and find related studies with complete human supervision. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

**About the Authors:**

**Dr. Shafiq ur Rehman** holds a Ph.D. in Applied Linguistics and TESOL with 17 years of experience in EFL teaching and academic leadership. He currently works at the University of Doha for Science & Technology, Qatar. His research interests include EdTech, language policy, EMI, and ESP. http://orcid.org/0000-0002-0412-4129

**Dr. Rabia Khatoon** holds a Ph.D. in Applied Linguistics and multiple teaching certifications. She works at King Abdulaziz University. Her research interests include writing instruction, language pedagogy, and the use of technologies in language teaching. https://orcid.org/0009-0001-7471-233X

**Dr. Intakhab Alam Khan** is a professor at King Abdulaziz University and holds over 27 years of experience in education, ESP, and curriculum development. He has authored 18 books and over 75 papers and led several funded research projects at various universities. https://orcid.org/0000-0001-7058-2200

**References**

Aguayo, C., & Eames, C. (2023). Using mixed reality (XR) immersive learning to enhance environmental education. *The Journal of Environmental Education*, *54*(1), 58–71. https://doi.org/10.1080/00958964.2022.2152410

Ai, Z. (2024). Challenges faced by English education in ethical minority areas under the background of Bilingual Education Policy for ethical minority students: Taking Yunnan Province as an example. *Transactions on Social Science, Education and Humanities Research*, *5*, 319–324. https://doi.org/10.62051/m83s2d29

Aljuaid, H. (2024). The Impact of Artificial Intelligence Tools on Academic Writing Instruction in Higher Education: A Systematic Review. *Arab World English Journal*, *1*(1), 26–55. https://doi.org/10.24093/awej/ChatGPT.2

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Celik, B., & Kara, S. (2024). Reaping the fruits of technology-integrated grammar instruction in EFL classes at the tertiary level through web 2.0 tools. *Novitas-ROYAL (Research on Youth and Language), 18*(1), 18–36. https://doi.org/10.5281/zenodo.10973103

Chen, X., Zou, D., Xie, H., & Cheng, G. (2021). Twenty years of personalized language learning. *Educational Technology & Society, 24*(1), 205-222. https://www.jstor.org/stable/26977868

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. SAGE Publications, Incorporated.

Divekar, R. R., Drozdal, J., Chabot, S., Zhou, Y., Su, H., Chen, Y., Zhu, H., Hendler, J. A., & Braasch, J. (2021b). Foreign language acquisition via artificial intelligence and extended reality: design and evaluation. *Computer Assisted Language Learning*, *35*(9), 2332–2360. https://doi.org/10.1080/09588221.2021.1879162

Gil-López, C., Guixeres, J., Marín-Morales, J., Torrecilla, C., Williams, E., & Alcañiz, M. (2023c). Is mixed reality technology an effective tool for retail? A vividness and interaction perspective. *Frontiers in Virtual Reality, 4.10.3389* https://doi.org/10.3389/frvir.2023.1067932

Hemphill, S., Rodriguez, S., Wang, E., Koeppen, K., Aitken-Young, B., Jackson, C., Simons, L., & Caruso, T. J. (2021b). Virtual reality augments movement during physical therapy. *American Journal of Physical Medicine & Rehabilitation*, *101*(3), 229–236. https://doi.org/10.1097/phm.0000000000001779

Hong, X., & Guo, L. (2025). Effects of AI-enhanced multi-display language teaching systems on learning motivation, cognitive load management, and learner autonomy. *Education and Information Technologies 30*(12), 17155–17189 (2025). https://doi.org/10.1007/s10639-025-13472-1

Issa Ahmad AlSaleem, B. (2023). The efficiency of metaverse platforms in language learning based on Jordanian young learners' perceptions. *Arab World English Journal*, *14*(1), 334–348. https://doi.org/10.24093/awej/vol14no1.21

Khodabandeh, F., Bagheri, A., & Mobarakeh, M. I. (2025b). Augmented reality's role in EFL learning: enhancing language skills in clothing and style through flipped and blended methods. *Virtual Reality*, *29*(2),90. https://doi.org/10.1007/s10055-025-01151-y

Kim, S. J. (2023). Virtual fashion experiences in virtual reality fashion show spaces. *Frontiers in Psychology*, *14*, 1276856. https://doi.org/10.3389/fpsyg.2023.1276856

Kumar, H., Gupta, P., & Chauhan, S. (2022). Meta-analysis of augmented reality marketing. *Marketing Intelligence & Planning*, *41*(1), 110–123. https://doi.org/10.1108/mip-06-2022-0221

Luan, F., Qu, B., & Pan, X. (2020). Human-machine integration interactive system based on mixed reality technology. *Journal of Physics Conference Series*, *1549*(2), 022128. https://doi.org/10.1088/1742-6596/1549/2/022128

Parmaxi, A., & Demetriou, A. A. (2020). Augmented reality in language learning: A state-of-the-art review of 2014–2019. *Journal of Computer Assisted Learning*, *36*(6), 861–875. https://doi.org/10.1111/jcal.12486

Ramadan Elbaioumi Shaddad, A., & Jember, B. (2024). A step toward effective language learning: an insight into the impacts of feedback-supported tasks and peer-work activities on learners' engagement, self-esteem, and language growth. *Asian-Pacific Journal of Second and Foreign Language Education*, *9*(1),39. https://doi.org/10.1186/s40862-024-00261-5

Strielkowski, W., Grebennikova, V., Lisovskiy, A., Rakhimova, G., & Vasileva, T. (2025). AI-driven adaptive learning for sustainable educational transformation. *Sustainable Development*, *33*(2), 1921-1947. https://doi.org/10.1002/sd.3221

Syahrin, S., & Akmal, N. (2024). Navigating the Artificial Intelligence frontier: Perceptions of instructors, students, and administrative staff on the role of artificial intelligence in education in the Sultanate of Oman. *Arab World English Journal*, *1*(1), 73–89. https://doi.org/10.24093/awej/chatgpt.4

Taşdemir, F., Atalay, E., & Çelikpazu, E. E. (2025). Development of the Grammar Learning Awareness Scale. *Frontiers in Education*, *9*, 1480823. https://doi.org/10.3389/feduc.2024.1480823

van Nooijen, C. C. A., De Koning, B. B., Bramer, W. M., Isahakyan, A., Asoodar, M., Kok, E., Van Merrienboer, J. J. G., & Paas, F. (2024). A Cognitive Load Theory Approach to Understanding Expert Scaffolding of Visual Problem-Solving Tasks: A Scoping review. *Educational Psychology Review*, *36*(1), 12. https://doi.org/10.1007/s10648-024-09848-3

Yannier, N., Hudson, S. E., Chang, H., & Koedinger, K. R. (2024). AI adaptivity in a Mixed-Reality system improves learning. *International Journal of Artificial Intelligence in Education*, *34*(4), 1541–1558. https://doi.org/10.1007/s40593-023-00388-5