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ARTICLE

Enhancing Reading Proficiency through Augmented Reality for Word Recognition Advancement

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ABSTRACT

This study investigates the effectiveness of Augmented Reality (AR) in enhancing word recognition among participants at the *frustration level*. Adopting a one-group pre-test-post-test design, the research involved 223 Grade 7 and Grade 8 learners from a public secondary school in the Philippines. The intervention utilized AR-powered reading books to immerse them in interactive and visually engaging word recognition activities. Results indicate an improvement in the post-test scores after the intervention. A significant difference was also observed between the pre-test and post-test scores. The results highlight the effectiveness of AR technology as a promising pedagogical tool in addressing challenges in word recognition. Future research endeavors should concentrate on addressing the existing gaps in the literature regarding AR interventions aimed at enhancing word recognition skills. It is recommended that such studies adopt longitudinal and comparative methodologies to explore the sustained effects of these interventions over time. Additionally, these studies should aim to identify best practices and uncover potential synergies between AR interventions and other instructional methods. This approach will contribute to a more comprehensive understanding of the effectiveness of AR in educational settings and its integration with traditional and innovative teaching strategies.

Keywords: Reading proficiency; Augmented reality; Word recognition; Intervention program; Interactive learning

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1. Introduction

Beyond being a mere academic prerequisite, proficiency in reading is a foundational competence that molds individuals' academic, professional, and personal paths (Nehring and Brunila, 2023; Venäläinen, 2023). Reading is a portal to knowledge that allows individuals to reach a wealth of information, diverse perspectives, and a wide array of ideas (Schmitt and Schmitt, 2014), laying the groundwork for critical thinking and analytical skills essential for academic achievement (Wilson, 2016).

Embarking on the journey toward reading proficiency constitutes a pivotal aspect of a child's educational trajectory (Liu et al., 2022), which is characterized by an intricate, multifaceted, and multisensorial developmental process involving several hurdles that may impact a child's overall learning experience (Blomert and Froyen, 2010; Nation, 2019; Schlesinger and Gray, 2017). Among these hurdles, word recognition emerges as a critical focal point (Castles et al., 2018), which plays a central role in the early stages of linguistic and reading proficiency development as a building block for more advanced reading competencies (Hoover and Gough, 1990; Levesque et al., 2021). Children may be confronted with difficulties in phonological awareness, coding, and decoding (Vellutino et al., 2007) that extend beyond mere impediments to word recognition, thus permeating the broader educational landscape and influencing a child's confidence, engagement with learning activities and academic achievement (Zhao et al., 2021).

Despite English being the medium of instruction in educational institutions, the Philippines performs poorly in reading. In 2018, the Philippines recorded the lowest reading score globally, with a score of 340, according to the Programme for International Student Assessment (PISA)—an international assessment system conducted by the Organization for Economic Co-operation and Development (OECD) (OECD, 2019a, 2019b, 2019c). Similarly, the recent 2022 PISA findings reveal that learners in the Philippines scored 347 in reading, which is still below the global average of 475 (Colicol and Sali-Latif, 2023; OECD, 2023a, 2023b).

In the context of one public secondary school in the Philippines, 223 out of 332 learners in grades 7 and 8 are categorized as being at the *frustration level* based on their School Monitoring, Evaluation, and Adjustments (SMEA)—a school-based mechanism to evaluate initiated interventions for continuous improvement (Datahan, 2020). The result implies that most learners have difficulty in reading, specifically in word recognition. This necessitates an innovative approach to address the complex challenges impeding reading proficiency.

While traditional methods may provide a structured framework for instruction, they might not offer the depth of engagement necessary for learners struggling with word recognition (Steen-Utheim and Foldnes, 2018). The uniform application of conventional teaching methods proves insufficient in addressing the diverse needs of learners, particularly those grappling with difficulties in recognizing fundamental words (Castro-Villarreal et al., 2016). A compelling imperative arises for a paradigm shift in instructional approaches—alternative methods, such as technology-integrated approaches, present potential avenues for augmenting word recognition skills (Manire et al., 2023). In particular, augmented Reality (AR) emerges as a promising and transformative force poised to reshape the educational landscape of word recognition instruction (Dargan et al., 2023; Huang et al., 2021; Lampropoulos et al., 2022; Leahy et al., 2019; Manire et al., 2023).

Hence, this study aimed to explore the effectiveness of AR in developing the word recognition skills of participants who belonged to the *frustration level*. It aspires to provide perspectives in addressing their specific educational needs, thereby contributing to the broader discourse on innovative pedagogical practices in literacy development.

2. Review of related literature and studies

The English language is recognized as the Philippines' second language mainly used as a medium of instruction and other tasks. The acquisition of

this must-learned language has been challenging for learners, and is being bored by traditional learning methods. As a result, language teachers face challenges in determining the optimal strategies to be used to develop learners' second language (Alvarez et al., 2024).

The use of AR as an emerging technology offers the capabilities of greatly enhancing the teaching and learning process, specifically in teaching and learning English reading (Mohamed Jamrus and Razali, 2021). Empirical evidence suggests that incorporating it in educational settings consistently enhances student motivation (Georgiou and Kyza, 2018) and positively impacts student learning outcomes (Lampropoulos et al., 2022). Furthermore, it has demonstrated a modest yet beneficial impact on students' learning attitudes, fostering their perception of the relevance of their learning to everyday life (Cai et al., 2020).

In the context of language teaching, AR offers substantial benefits in contextualizing language acquisition within real-world scenarios (Lee and Park, 2020). Similar to other disciplines, technology has positively impacted motivation and participation among students learning English as a second language (Hsu, 2017). This also provides additional advantages, including increased collaboration among students and improved retention and execution of tasks, all of which contribute to productive language development (Chen et al., 2020). AR is predominantly utilized in classrooms through two primary avenues: educational gaming (Radu, 2014) and learning materials (Greenhow and Askari, 2017).

Despite the pervasive influence of web technologies and the internet, printed books used for reading remain prominent, reflecting a preference for tactile reading experiences (Kesim and Ozarslan, 2012). AR introduces a novel dimension to conventional textbooks through AR-enhanced editions (Kesim and Ozarslan, 2012). Users unlock visualizations and interactive features facilitated by specialized software or mobile applications by employing a webcam to scan the book (Mewes et al., 2017). This transformative technology imbues static printed pages with dynamic 3D objects, multimedia components, and interactive simulations, effectively bridging the schism between physical and digital realms (Mitterberger et al., 2020). Consequently, individuals with limited computer literacy can partake in immersive and interactive learning encounters (Dawley and Dede, 2014).

Moreover, pioneering studies in AR for educational purposes have shown promising results, such as the development of MOW (a game designed to teach children the names of animals in both English and Portuguese) and AR Magic English (a mobile AR interaction game for vocabulary learning) (Minaee et al., 2022). Additionally, investigations into AR pop-up books for reading have found that they increase students' motivation to learn English (Vate-U-Lan, 2012). More so, numerous mobile phone applications for both iOS and Android platforms serve as valuable teaching and learning tools for English (Wu Q., 2015). Further, experimental studies have evaluated the effectiveness of AR applications in teaching the English alphabet to kindergarten children, demonstrating differences in interaction with the English alphabet lesson between control and experimental groups. The study aimed at enhancing English vocabulary and grammar learning among young students has positively affected learning outcomes and levels of motivation and participation (Safar et al., 2017).

Despite the benefits of AR in educational settings, several barriers hinder its successful implementation in the classroom (Fernández-Batanero et al., 2024). One major obstacle is the time and technical expertise required to develop its materials (Wu H.K., et al., 2013). Teachers often lack the necessary training and skills to troubleshoot technical issues that may arise when using the technology (Tzima et al., 2019). Consequently, they may require substantial support to ensure positive outcomes when integrating AR into their teaching practices (Romano et al., 2023). They must acquire the skills needed to incorporate them into their curriculum to avoid overreliance on information technology professionals with a limited understanding of effective pedagogical practices

(Muluk et al., 2019).

AR integration into the classroom has been limited, resulting in a scarcity of use cases to inform teacher practice (Fernández-Batanero et al., 2024). To effectively implement, teachers must believe in its potential to enhance pedagogy and understand which teaching and learning strategies are best suited (Tzima et al., 2019). A number of barriers to teachers' effective integration of technology is the lack of a conceptual framework for implementing technologies like AR systems (Alalwan et al., 2020). Without such frameworks, the application of technology within the classroom may be superficial and fail to produce meaningful learning outcomes (González-Pérez and Ramírez-Montoya, 2022).

3. Materials and methods

This investigation adopted a one-group pretest-posttest design, a methodological framework deliberately selected to examine the effect of AR on the word recognition proficiency of the study participants. Central to this design is systematically evaluating participants' reading competencies before (pretest) and after the intervention period (post-test). The primary objective is to discern enhancement in the participants' word recognition capabilities attributed to the incorporation of AR technology.

The materials used in the study was the Philippine Informal Reading Inventory (Phil-IRI) by the Department of Education for measuring and describing the reading performance of the learners (Abocejo et al., 2022; Figuracion and Ormilla, 2021). It is an assessment tool composed of graded passages to determine a learner's reading level (Fabella and Abaoag, 2023). The computation of the error rate was facilitated by calculating the percentage of mispronounced words, termed miscues, concerning the total number of words. Within this context, miscues represent instances where learners inaccurately pronounced words. This computation aims to discern the extent to which words were accurately pronounced. A predetermined set of criteria delineated distinct categories among the participants, facilitating a comprehensive classification process. This includes:

Reading Level	Score
Independent	97–100
Instructional	90–96
Frustration	89–below

Learners who achieve scores of 89 or below are categorized within the *frustration level*. It indicates that they find reading materials exceedingly challenging and are unable to respond successfully to them. Those who attain scores ranging from 90 to 96 are placed within the *instructional level*, suggesting that they benefit maximally from teacher-directed reading instruction. Learners who score between 97 and 100 are classified at the *independent level*, which signifies their ability to function autonomously, characterized by nearly flawless oral reading and comprehension skills.

The study encompassed 223 Grade 7 and Grade 8 learners from a public secondary school in the Philippines. Participants were purposively selected following an initial evaluation by the School Monitoring, Evaluation, and Adjustment (SMEA) utilizing Phil-IRI. Specifically, they were chosen based on their classification within the *frustration level* in word recognition after the assessment, indicating a discernible challenge in reading. This homogenous sample helps in attributing any observed changes or effects directly to the intervention rather than to underlying differences. Also, the scores were subjected to Kolmogorov-Smirnov (K-S) test to assess the normality. It quantified the maximum distance between the empirical distribution function of the sample and the cumulative distribution function of the normal distribution. The result yielded a D value of 0.07406 which means a relatively small deviation between the observed data distribution and the expected normal distribution. Hence, it suggested that the data are not far off from being normally distributed. Complementing this, the p-value of 0.16468 is greater than the alpha level (0.05), which indicates that the difference is not statistically significant. Thus, it implies that the assumption of normality for the data in question is reasonable. Learners with *instructional* and *independent* reading levels were excluded from the study.

The participants were subsequently exposed to an intervention utilizing innovative AR books such as Tigra Live Animations—Hippo Magic (Tigra Live Animations, 2017) and GoonAR (Desierto et al., 2020), which are applications that will bring the stories to life. These books (see **figures 2** and **4**) offer a captivating and interactive reading experience. They encompass various alphabets and storybooks that foster an engaging platform for the participants. The technology is further enhanced by a user-friendly mobile application (see **figures 1** and **3**) that supports its functionalities that can be downloaded.

Figure 1. Interface of GoonAR.

Figure 2. GoonAR physical book.

Figure 3. Interface of Hippo Magic.

Figure 4. Hippo Magic physical book.

The researchers initiated the study by seeking approval from the school principal, ensuring that the administrative protocols were adhered to. Subsequently, a meeting was convened involving the participants, their parents, and teachers to provide an orientation about the study's objectives and procedures. During this session, the importance of informed consent and assent was emphasized, and all necessary forms were completed to document the participants' and their guardians' agreement to partake in the study. Participants and their families were instructed to download specific applications on their mobile devices, which were essential for the intervention. This step was crucial in preparing for the interactive elements of the study, particularly the use of AR technologies. A daily one-hour engagement was conducted in the reading room designated for the study. Participants were not only given access to the necessary technology but were also guided on how to operate it effectively. This guidance was aimed at familiarizing them with the AR interface, which is vital for ensuring that the technology serves its educational purpose rather than becoming a source of frustration or confusion. Throughout the study, the researchers maintained close monitoring of the participants. This supervision was essential to ensure that the students navigated the AR environment correctly and effectively, thereby maximizing the potential educational benefits of the technology. Such meticulous oversight helped to mitigate any technical issues and ensured that the study's objectives were met through proper usage of the AR applications. The AR intervention transpired in linguistic chronology, commencing with phonemes, words, and

sentences. The intervention lasted over 1 ½ months, from November 2023 to the middle of January 2024. This provides a practical period to gather enough data and reduces the risk of attrition bias, potentially skewing results. Following the intervention period, which was carried out consistently without a hitch, the participants were re-evaluated using Phil-IRI to gauge the efficacy of AR in augmenting their reading capabilities.

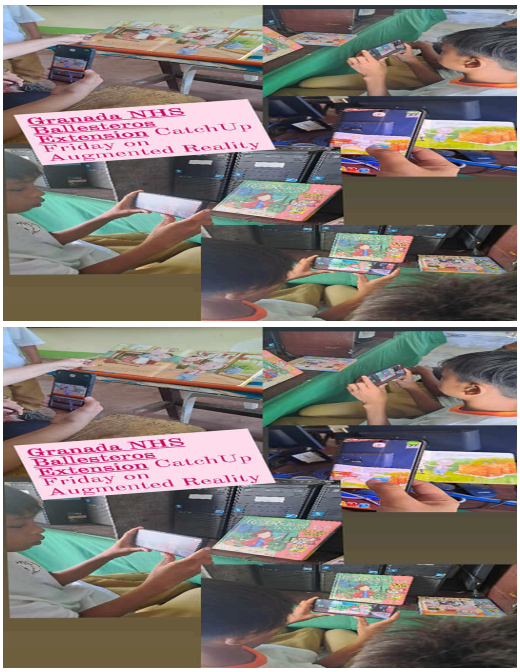

Figure 5. Participants during the intervention.

4. Results

4.1 Pre-test and post-test scores

The participants were subjected to a pre-assessment of their word recognition skills utilizing the reading passages provided in the PHIL-IRI package, along with its corresponding evaluative criteria. Based on their performance, they were classified into three distinct levels: *frustration*, *instructional*, and *independent*. Each level reflects a specific range of competencies in word recognition, designed to accurately gauge the participants' reading abilities and facilitate targeted instructional strategies. Using frequency and percentages, **Table 1** reveals that all participants (223 or 100%) were at the *frustration level*. The reading materials were so challenging for them that they could not engage successfully. Hence, they inaccurately pronounced words.

However, following the intervention, the number of participants who belonged to the *frustration level* markedly decreased to only 93 participants (41.70%). This indicates a reduction in the difficulties associated with word recognition. The change suggests that the intervention was effective in advancing to higher reading levels among them. A total of 121 individuals (54.26%) progressed to the *instructional level*. It is a stage at which they benefit greatly from teacher-directed instruction. This level is crucial as it provides structured learning that builds on each learner's capabilities, enhancing both their skills and confidence. Additionally, 9 participants (4.04%) reached the *independent level*, where the participants demonstrated almost perfect oral reading and excellent comprehension. At this level, they are able to function autonomously, effectively understanding and interpreting text on their own.

Table 1. Pre-test and post-test scores.

Reading levels	Pre-test		Post-test	
	f	%	f	%
Frustration	223	100	93	41.70
Instructional	0	0	121	54.26
Independent	0	0	9	4.04

4.2 Difference of pre-test and post-test scores

Table 2 shows a significant difference in participants' pre-test and post-test scores using a paired sample t-test. It reveals that the average is –25.44, indicating a drop in scores after the intervention. In addition, the standard deviation of 17.07 reflects the variability in score changes across the group. This suggests that participants may have experienced varying degrees of improvement or decline in their scores.

The 95% confidence interval of the difference, ranging from –27.70 to –23.19, underscores the high confidence level in assessing the true mean difference between pre-test and post-test scores. This narrow confidence interval indicates a relatively precise

estimation of the observed change's magnitude.

Furthermore, the t-value of –22.25 carries statistical weight, especially considering the ample sample size (df = 222) and the remarkably low p-value (0.000). These suggest that the decrease in scores is highly unlikely to be attributed to chance alone. Instead, it strongly suggests that the intervention considerably impacted the performance, leading to the observed decline in scores from the pre-test to the post-test phase.

Table 2. Results of the difference.

95% confidence interval of the difference							
	M	**SD**	**Lower**	**Upper**	**t**	**df**	**p**
Pre-test-Post-test	–25.44	17.07	–27.70	–23.19	–22.25	222	.000

[1] $p < 0.05$, statistically significant at 0.05 alpha level.

5. Discussion

Participants under *frustration level* could not respond successfully as they were challenged by the reading materials. This difficulty often leads to a negative self-concept regarding their academic abilities, which can spiral into anxiety or a defeated attitude toward reading (Retelsdorf et al., 2014). Such negative emotions tend to perpetuate a cycle of avoidance (Onatsu-Arvilommi and Nurmi, 2000)—participants engage less. This, in turn, limits their improvement and reinforces their initial struggles (Torgesen, 2002).

Additionally, participants may encounter intrinsic challenges, such as dyslexia or other learning disabilities, which make reading a particularly arduous task (Poskiparta et al., 2003). The substantial effort required to decode text can result in cognitive overload, thereby discouraging active participation in reading activities (Dunne, 2024). Moreover, if their foundational reading skills like phonemic awareness, fluency, and comprehension are underdeveloped (Tunmer and Hoover, 2019), the reading experience can become increasingly frustrating and demotivating (Stevani and Karisma Erikson Tarigan, 2022). Another critical factor is the lack of adequate support from educators or instructional materials that fail to meet the diverse needs of these participants (Moreau, 2014). Without targeted intervention and appropriate support, they remain at a stagnant level of word recognition (Pace Miles et al., 2019), which hinders not only their performance in literacy-related subjects but also their academic success and motivation to learn (Yang et al., 2018).

More so, the swift transition to remote learning during the COVID-19 pandemic led to a reduction in direct teacher instruction and individualized attention (Colclasure et al., 2021). Direct teacher instruction in traditional classroom settings often involves interactive and immediate feedback mechanisms that are critical for teaching complex skills such as phonics and reading (Ehri et al., 2001; Scarparolo and Hammond, 2018). Teachers are able to adjust their instructional pace (Rolf and Slocum, 2021), employ responsive teaching methods (Abry et al., 2013), and directly observe student reactions (Gunn et al., 2021). However, the remote learning environment often lacked these dynamic interactions (Wallace, 2003). This limitation was challenging for subjects like reading (Sagin Simsek, 2008), where phonetic cues and pronunciation are better taught through direct and immediate verbal interaction (Kissling, 2014; Loewen and Isbell, 2017; Saito, 2013).

The post-test results feature the efficacy of AR intervention as a pedagogical tool in enhancing word recognition skills among participants who are operating at a *frustration level*. AR offers an immersive and interactive learning experience that allows the participants to engage with digital content in real-world environments (Salvetti and Bertagni, 2019). Also, it accurately reproduces native pronunciation patterns, intonations, and accents (Rogerson-Revell, 2021) that refine their speaking skills in real time (Ding et al., 2019). Access to native-like pronunciation empowers them to develop a more authentic and fluent command of the language (Mohammed Ishaque, 2018). Moreover, the dynamic presentation of words and images provides them with a multisensory learning experience that can aid in developing their word recognition skills (Hald et al., 2016). Studies have shown that the interactive nature of AR technology

can help reinforce word-sound associations (Fan et al., 2020), improve visual discrimination skills (Carbonell Carrera and Bermejo Asensio, 2017), and enhance reading comprehension (Tobar-Muñoz et al., 2017). Thus, it allows for personalized learning experiences, enabling the participants to progress at their own pace, which can further support the development of their word recognition skills (Sungkur et al., 2016).

Also, learners exposed to AR-based reading interventions exhibited reading comprehension improvements more than those in traditional instructional settings (Ebadi and Ashrafabadi, 2022; Şimşek and Direkçi, 2023). They have reported experiencing lower cognitive load, increased motivation, and more positive attitudes towards learning when interacting with AR books. These factors combine to create a more engaging and effective learning environment, where students are not only more inclined to learn but also able to do so in a manner that aligns with their individual capabilities and preferences (Cheng, 2017). This finding aligns with Mayer's Cognitive Theory of Multimedia Learning, which posits that presenting information through multiple sensory channels enhances cognitive processing and learning outcomes (Mayer, 2017). This simultaneous stimulation creates a dynamic and immersive educational environment that enhances cognitive processing and learning effectiveness. The inherent multisensory approach of AR is particularly advantageous as it accommodates a wide range of learning styles and preferences, ensuring a more inclusive educational experience. Moreover, AR provides benefits for learners who encounter difficulties with conventional text-based instructional methods (Childs et al., 2023; Mohana et al., 2023). Embedding words within authentic contexts enhances comprehension and facilitates vocabulary acquisition (Uz Bilgin and Tokel, 2018; Zhou and Wei, 2018) because learners are immersed in relevant scenarios where they encounter words in authentic use. Hence, it provides contextual cues that promote understanding and retention (Weerasinghe et al., 2022). This corresponds with Vygotsky's Sociocultural Theory, underscoring the significance of social interactions and meaningful contexts in cognitive development (Ferreira et al., 2021). According to this theory, learning is inherently a social process that is deeply influenced by the interaction between individuals and their cultural context. By situating words within meaningful, real-world scenarios, learners are actively engaging in the construction of knowledge through context. This approach enhances word recognition skills by linking new vocabulary to existing cognitive structures and personal experiences. Thus, it promotes not only retention but also the ability to apply knowledge in varied situations. Such contextualization is vital for deepening understanding and facilitating the effective transfer of knowledge across different contexts and situations.

While AR offers innovative opportunities for enhancing learning through interactive and immersive experiences, some studies find the technology as a hindrance to traditional paper book reading. Some parents categorized within the "parent as dominator" group appeared to exert considerable control over the reading process, primarily to curb their children's excessive use of mobile devices. This behavior reflects a protective stance, likely driven by concerns over screen time and the potential impacts on traditional literacy skills (Cheng and Tsai, 2016). Dunleavy et al. (2009) documented challenges faced by students during multi-user AR simulations, highlighting that participants often felt overwhelmed and confused. This response was attributed to the dual demands of navigating unfamiliar technologies while simultaneously managing complex tasks within the AR environment. The introduction of new technological interfaces, combined with the cognitive load required to process and integrate multiple streams of information in real time, can create a steep learning curve. These factors can detract from the educational effectiveness of AR simulations unless adequate support and training are provided. Complex tasks such as spatial navigation, collaboration, problem-solving, technology manipulation, and mathematical estimation require students to integrate multiple skills (Dunleavy et al., 2009). Previous research has indi-

cated that a significant barrier to effective learning within AR environments is students' lack of these essential skills (Kerawalla et al., 2006; Klopfer and Squire, 2008; Squire and Jan, 2007). This challenge is particularly pronounced for younger learners and novices who are inexperienced in conducting open-ended investigations. Hence, AR successful integration depends on thoughtful consideration of its impacts, the readiness of users, and the provision of adequate support. By addressing these areas, educators can maximize the benefits of this technology while mitigating its potential drawbacks.

6. Conclusions

The ongoing difficulty with word recognition exhibited by the participants represents a critical issue within the educational landscape. This challenge is not an isolated occurrence; rather, it persists as learners progress from earlier academic stages, suggesting that previous educational interventions might have been inadequate or improperly aligned with the specific requirements of these learners. As they continue their educational journey, they encounter increasingly complex textual materials. This escalation can intensify their struggles with foundational literacy deficits, potentially precipitating a series of adverse outcomes. Such outcomes include diminished academic performance, a decline in motivation, and an elevated risk of disengagement from the educational process. The accumulation of these issues not only hampers the academic trajectory of the affected learners but also poses implications for educators and policy makers tasked with designing effective literacy interventions. Thus, it is imperative that educational strategies are carefully evaluated and adapted to meet the evolving demands of learners' literacy development, ensuring they are equipped with the necessary skills to manage and excel in the face of increasing academic challenges.

This research offers evidence that AR is a potent instrument for improving word recognition skills, a foundational element of literacy. The data clearly indicate enhancements in learners' ability to recognize words, confirming the efficacy of AR in this domain. The success of AR in facilitating these improvements positions it as a potentially transformative force in educational technology, particularly for learners who find traditional instructional methods ineffective. This is vital, as these learners frequently fail to thrive within conventional educational frameworks. The findings underscore the necessity of re-evaluating and possibly reinventing educational strategies to incorporate AR. It ensures that all learners have the opportunity to succeed and benefit from innovative educational interventions.

7. Future works

Future research should delve into the gaps in current literature to enhance understanding of how AR interventions improve word recognition skills. Longitudinal studies are crucial to assess its long-term effects on reading development and academic performance. Comparative studies are vital for examining its impact across diverse learner demographics and educational settings, aiming to determine which AR features best serve different groups. This could help in crafting customized strategies that optimize educational outcomes. Incorporating qualitative research methods—such as interviews, focus groups, and ethnographic studies—will enrich these findings by providing detailed insights into the experiences and perceptions of learners and educators interacting with AR technology. Furthermore, exploring how it could be synergistically combined with other instructional strategies, like multimedia learning, game-based learning, and cognitive training, might reveal innovative ways to boost the efficacy of literacy interventions. By integrating both quantitative and qualitative research approaches, future studies could provide a comprehensive perspective on AR's potential in education, guiding the advancement of more effective, inclusive, and adaptable educational technologies.

Author Contributions

The manuscript was authored by Bon Eric A. Besonia. Jan Carlo T. Arroyo and Allemar Jhone P.

Delima contributed substantially to the finalization of the manuscript's drafting, ensuring its coherence and academic rigor. The implementation of the study and the gathering of empirical data were facilitated by the diligent efforts of Shiela Mae H. Espora, Rizzamila R. Superio, Marieth Flor M. Bernardez, Mark Ronar G. Galagala, and Jay Ann E. Bales.

Conflict of Interest

The authors assert the absence of conflicts of interest.

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References

Abril, J.G., Acerbo, C.T., Abocejo, F.T., 2022. The Philippine informal reading inventory (Phil-IRI) program: A critical analysis. Budapest International Research and Critics in Linguistics and Education (BirLE) Journal. 5(4), 432–441.

Abry, T., Rimm-Kaufman, S.E., Larsen, R.A., et al., 2013. The influence of fidelity of implementation on teacher–student interaction quality in the context of a randomized controlled trial of the Responsive Classroom approach. Journal of School Psychology. 51(4), 437–453.

DOI: https://doi.org/10.1016/j.jsp.2013.03.001

Alalwan, N., Cheng, L., Al-Samarraie, H., et al., 2020. Challenges and prospects of virtual reality and augmented reality utilization among primary school teachers: A developing country perspective. Studies in Educational Evaluation. 66, 100876.

DOI: https://doi.org/10.1016/j.stueduc.2020.100876

Alvarez, J.C., Cuebillas, C.I., Solano, S.B., et al., 2024. Impact of TikTok application to the second language acquisition of grade 10 students. SHS Web Conf. 182, 03002.

DOI: https://doi.org/10.1051/shsconf/202418203002

Blomert, L., Froyen, D., 2010. Multi-sensory learning and learning to read. International Journal of Psychophysiology. 77(3), 195–204.

DOI: https://doi.org/10.1016/j.ijpsycho.2010.06.025

Cai, S., Liu, E., Shen, Y., et al., 2020. Probability learning in mathematics using augmented reality: Impact on student's learning gains and attitudes. Interactive Learning Environments. 28(5), 560–573.

DOI: https://doi.org/10.1080/10494820.2019.1696839

Carbonell Carrera, C., Bermejo Asensio, L.A., 2017. Augmented reality as a digital teaching environment to develop spatial thinking. Cartography and Geographic Information Science. 44(3), 259–270.

DOI: https://doi.org/10.1080/15230406.2016.1145556

Castles, A., Rastle, K., Nation, K., 2018. Ending the reading wars: Reading acquisition from novice to expert. Psychological Science in the Public Interest. 19(1), 5–51.

DOI: https://doi.org/10.1177/1529100618772271

Castro-Villarreal, F., Villarreal, V., Sullivan, J.R., 2016. Special education policy and response to intervention: Identifying promises and pitfalls to advance social justice for diverse students. Contemporary School Psychology. 20(1), 10–20.

DOI: https://doi.org/10.1007/s40688-015-0077-3

Chen, L., Chen, P., Lin, Z., 2020. Artificial intelligence in education: A review. IEEE Access. 8, 75264–75278.

DOI: https://doi.org/10.1109/ACCESS.2020.2988510

Cheng, K.H., 2017. Reading an augmented reality book: An exploration of learners' cognitive load, motivation, and attitudes. Australasian Journal of Educational Technology. 33(4).

DOI: https://doi.org/10.14742/ajet.2820

Cheng, K.H., Tsai, C.C., 2016. The interaction of child–parent shared reading with an augmented reality (AR) picture book and parents' conceptions of AR learning. British Journal of Educational Technology. 47(1), 203–222.

DOI: https://doi.org/10.1111/bjet.12228

Childs, E., Mohammad, F., Stevens, L., et al., 2023. An overview of enhancing distance learning through emerging augmented and virtual reality technologies. IEEE Transactions on Visualization and Computer Graphics. 30(8), 4480–4496.

DOI: https://doi.org/10.1109/TVCG.2023.3264577

Colclasure, B.C., Marlier, A., Durham, M.F., et al., 2021. Identified challenges from faculty teaching at predominantly undergraduate institutions after abrupt transition to emergency remote teaching during the COVID-19 pandemic. Education Sciences. 11(9), 556.

DOI: https://doi.org/10.3390/educsci11090556

Colicol, F.L., Sali-Latif, F.K., 2023. Parental occupation, social class, and school choice in Southern Philippines: Their implications to educational public-private partnership vis-à-vis the K-12 SHS voucher program. International Journal of Learning, Teaching and Educational Research. 22(6), 345–369.

DOI: https://doi.org/10.26803/ijlter.22.6.19

Dargan, S., Bansal, S., Kumar, M., et al., 2023. Augmented reality: A comprehensive review. Archives of Computational Methods in Engineering. 30(2), 1057–1080.

DOI: https://doi.org/10.1007/s11831-022-09831-7

Datahan, P.J., 2020. School monitoring evaluation and adjustment in public secondary schools: Practices and performance of administrators. Journal of World Englishes and Educational Practices. 2(2), 146–157.

Dawley, L., Dede, C., 2014. Situated learning in virtual worlds and immersive simulations. Handbook of research on educational communications and technology. Springer: New York. pp. 723–734.

DOI: https://doi.org/10.1007/978-1-4614-3185-5_58

Desierto, A.J.R., Reciña, A.S.A., Arroyo, J.C.T., et al., 2020. GoonAR: A bilingual children storybook through augmented reality technology using unity with Vuforia framework. International Journal of Advanced Trends in Computer Science and Engineering. 9(3), 3681–3686.

DOI: https://doi.org/10.30534/ijatcse/2020/180932020

Ding, S., Liberatore, C., Sonsaat, S., et al., 2019. Golden speaker builder – an interactive tool for pronunciation training. Speech Communication. 115, 51–66.

DOI: https://doi.org/10.1016/j.specom.2019.10.005

Dunleavy, M., Dede, C., Mitchell, R., 2009. Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. Journal of Science Education and Technology. 18(1), 7–22.

DOI: https://doi.org/10.1007/s10956-008-9119-1

Dunne, C., 2024. Design strategies and dyslexia: Improving the accessibility of course material for third-level students with dyslexia [Master's thesis]. Dublin: Institute of Art, Design + Technology.

Ebadi, S., Ashrafabadi, F., 2022. An exploration into

the impact of augmented reality on EFL learners' Reading comprehension. Education and Information Technologies. 27(7), 9745–9765.

DOI: https://doi.org/10.1007/s10639-022-11021-8

Ehri, L.C., Nunes, S.R., Stahl, S.A., et al., 2001. Systematic phonics instruction helps students learn to read: Evidence from the national reading panel's meta-analysis. Review of Educational Research. 71(3), 393–447.

DOI: https://doi.org/10.3102/00346543071003393

Fabella, M.D.G., Abaoag, N.M., 2023. Intermediate grade school learners' sex, word recognition, and reading comprehension. World Journal of Advanced Research and Reviews. 20(3), 1346–1356.

DOI: https://doi.org/10.30574/wjarr.2023.20.3.2270

Fan, M., Antle, A.N., Warren, J.L., 2020. Augmented reality for early language learning: A systematic review of augmented reality application design, instructional strategies, and evaluation outcomes. Journal of Educational Computing Research. 58(6), 1059–1100.

DOI: https://doi.org/10.1177/0735633120927489

Fernández-Batanero, J.M., Montenegro-Rueda, M., Fernández-Cerero, J., et al., 2024. Extended reality as an educational resource in the primary school classroom: An interview of drawbacks and opportunities. In Computers. 13(2), 50.

DOI: https://doi.org/10.3390/computers13020050

Ferreira, J.M., Moura, G.G., de Melo Mieto, G.S., 2021. Children's sociability in institutional contexts: Theoretical reflections on cognitive development within peer interactions. Human Arenas. 4(2), 218–238.

DOI: https://doi.org/10.1007/s42087-020-00113-x

Figuracion, V.C., Ormilla, R.C.G., 2021. The word reading performance of grade V pupils through a library hour program in Philippines. EDUCATUM Journal of Social Sciences. 7(1), 95–103.

DOI: https://doi.org/10.37134/ejoss.vol7.1.10.2021

Georgiou, Y., Kyza, E.A., 2018. Relations between student motivation, immersion and learning outcomes in location-based augmented reality settings. Computers in Human Behavior. 89, 173–181.

DOI: https://doi.org/10.1016/j.chb.2018.08.011

González-Pérez, L.I., Ramírez-Montoya, M.S., 2022. Components of education 4.0 in 21st century skills frameworks: Systematic review. Sustainability. 14(3), 1493.

DOI: https://doi.org/10.3390/su14031493

Greenhow, C., Askari, E., 2017. Learning and teaching with social network sites: A decade of research in K-12 related education. Education and Information Technologies. 22(2), 623–645.

DOI: https://doi.org/10.1007/s10639-015-9446-9

Gunn, B., Smolkowski, K., Strycker, L.A., et al., 2021. Measuring explicit instruction using classroom observations of student–teacher interactions (COSTI). Perspectives on Behavior Science. 44(2), 267–283.

DOI: https://doi.org/10.1007/s40614-021-00291-1

Hald, L.A., de Nooijer, J., van Gog, T., et al., 2016. Optimizing word learning via links to perceptual and motoric experience. Educational Psychology Review. 28(3), 495–522.

DOI: https://doi.org/10.1007/s10648-015-9334-2

Hoover, W.A., Gough, P.B., 1990. The simple view of reading. Reading and Writing. 2(2), 127–160.

DOI: https://doi.org/10.1007/BF00401799

Hsu, T.C., 2017. Learning English with augmented reality: Do learning styles matter?. Computers & Education. 106, 137–149.

DOI: https://doi.org/10.1016/j.compedu.2016.12.007

Huang, X., Zou, D., Cheng, G., et al., 2021. A systematic review of AR and VR enhanced language learning. Sustainability. 13(9), 4639.

DOI: https://doi.org/10.3390/su13094639

Kerawalla, L., Luckin, R., Seljeflot, S., et al., 2006. "Making it real": Exploring the potential of augmented reality for teaching primary school science. Virtual Reality. 10(3), 163–174.

DOI: https://doi.org/10.1007/s10055-006-0036-4

Kesim, M., Ozarslan, Y., 2012. Augmented reality in education: Current technologies and the potential for education. Procedia - Social and Behavioral Sciences. 47, 297–302.

DOI: https://doi.org/10.1016/j.sbspro.2012.06.654

Kissling, E.M., 2014. Phonetics instruction improves learners' perception of L2 sounds. Language Teaching Research. 19(3), 254–275.

DOI: https://doi.org/10.1177/1362168814541735

Klopfer, E., Squire, K., 2008. Environmental detectives—the development of an augmented reality platform for environmental simulations. Educational Technology Research and Development. 56(2), 203–228.

DOI: https://doi.org/10.1007/s11423-007-9037-6

Lampropoulos, G., Keramopoulos, E., Diamantaras, K., et al., 2022. Augmented reality and gamification in education: A systematic literature review of research, applications, and empirical studies. Applied Sciences. 12(13), 6809.

DOI: https://doi.org/10.3390/app12136809

Leahy, S.M., Holland, C., Ward, F., 2019. The digital frontier: Envisioning future technologies impact on the classroom. Futures. 113, 102422.

DOI: https://doi.org/10.1016/j.futures.2019.04.009

Lee, S.M., Park, M., 2020. Reconceptualization of the context in language learning with a location-based AR app. Computer Assisted Language Learning. 33(8), 936–959.

DOI: https://doi.org/10.1080/09588221.2019.1602545

Levesque, K.C., Breadmore, H.L., Deacon, S.H., 2021. How morphology impacts reading and spelling: Advancing the role of morphology in models of literacy development. Journal of Research in Reading. 44(1), 10–26.

DOI: https://doi.org/10.1111/1467-9817.12313

Liu, H., Chen, X., Liu, X., 2022. Factors influencing secondary school students' reading literacy: An analysis based on XGBoost and SHAP methods. Frontiers in Psychology. 13, 948612.

DOI: https://doi.org/10.3389/fpsyg.2022.948612

Loewen, S., Isbell, D.R., 2017. Pronunciation in face-to-face and audio-only synchronous computer-mediated learner interactions. Studies in Second Language Acquisition. 39(2), 225–256.

DOI: https://doi.org/10.1017/S0272263116000449

Manire, E., Kilag, O.K., Cordova Jr., N., et al., 2023. Artificial intelligence and English language learning: A systematic review. Excellencia: International Multi-Disciplinary Journal of Education. 1(5), 485–497.

Mayer, R.E., 2017. Using multimedia for e-learning. Journal of Computer Assisted Learning. 33(5), 403–423.

DOI: https://doi.org/10.1111/jcal.12197

Mewes, A., Hensen, B., Wacker, F., et al., 2017. Touchless interaction with software in interventional radiology and surgery: A systematic

literature review. International Journal of Computer Assisted Radiology and Surgery. 12(2), 291–305.

DOI: https://doi.org/10.1007/s11548-016-1480-6

Minaee, S., Boykov, Y., Porikli, F., et al., 2022. Image segmentation using deep learning: A survey. IEEE Transactions on Pattern Analysis and Machine Intelligence. 44(7), 3523–3542.

DOI: https://doi.org/10.1109/TPAMI.2021.3059968

Mitterberger, D., Dörfler, K., Sandy, T., et al., 2020. Augmented bricklaying. Construction Robotics. 4(3), 151–161.

DOI: https://doi.org/10.1007/s41693-020-00035-8

Mohamed Jamrus, M.H., Razali, A.B., 2021. Acceptance, readiness and intention to use augmented reality (AR) in teaching English reading among secondary school teachers in Malaysia. Asian Journal of University Education. 17(4), 312–326.

DOI: https://doi.org/10.24191/ajue.v17i4.16200

Mohammed Ishaque, R.K., 2018. Empowering English speakers through diversification and promotion of world Englishes. Advances in Language and Literary Studies. 9(6), 93.

DOI: https://doi.org/10.7575/aiac.alls.v.9n.6p.93

Mohana, M., Valliammal, N., Suvetha, V., et al. (editors), 2023. A study on technology-enhanced mulsemedia learning for enhancing learner's experience in e-learning. 2023 International Conference on Network, Multimedia and Information Technology (NMITCON); 2023 Sep 1–2; Bengaluru, India. IEEE: New York.

DOI: https://doi.org/10.1109/NMITCON58196.2023.10275964

Moreau, L.K., 2014. Who's really struggling?: Middle school teachers' perceptions of struggling readers. RMLE Online. 37(10), 1–17.

DOI: https://doi.org/10.1080/19404476.2014.11462113

Muluk, S., Habiburrahim, H., Zulfikar, T., et al., 2019. Developing generic skills at an Islamic higher education institution curriculum in Aceh, Indonesia. Higher Education, Skills and Work-Based Learning. 9(3), 445–455.

DOI: https://doi.org/10.1108/HESWBL-06-2018-0064

Nation, K., 2019. Children's reading difficulties, language, and reflections on the simple view of reading. Australian Journal of Learning Difficulties. 24(1), 47–73.

DOI: https://doi.org/10.1080/19404158.2019.1609272

Nehring, D., Brunila, K., 2023. Affective capitalism in academia: Revealing public secrets. Policy Press: Bristol.

DOI: https://doi.org/10.51952/9781447357865

OECD, 2019a. PISA 2018 results (Volume I): What students know and can do.

DOI: https://doi.org/10.1787/5f07c754-en

OECD, 2019b. PISA 2018 results (Volume II): Where all students can succeed.

DOI: https://doi.org/10.1787/b5fd1b8f-en

OECD, 2019c. PISA 2018 results (Volume III): What school life means for students' lives.

DOI: https://doi.org/10.1787/acd78851-en

OECD, 2023a. PISA 2022 results (Volume I): The state of learning and equity in education.

DOI: https://doi.org/10.1787/53f23881-en

OECD, 2023b. PISA 2022 results (Volume II): Learning during – and from – disruption.

DOI: https://doi.org/10.1787/a97db61c-en

Onatsu-Arvilommi, T., Nurmi, J.-E. (2000). The role of task-avoidant and task-focused behaviors

in the development of reading and mathematical skills during the first school year: A cross-lagged longitudinal study. Journal of Educational Psychology. 92(3), 478–491.

DOI: https://doi.org/10.1037/0022-0663.92.3.478

Pace Miles, K., Lauterbach, M.D., Murano, D.M., et al., 2019. Reading rescue: A follow-up on effectiveness of an intervention for struggling readers. The Journal of Educational Research. 112(2), 255–269.

DOI: https://doi.org/10.1080/00220671.2018.1514358

Poskiparta, E., Niemi, P., Lepola, J., et al., 2003. Motivational-emotional vulnerability and difficulties in learning to read and spell. British Journal of Educational Psychology. 73(2), 187–206.

DOI: https://doi.org/10.1348/0007099036062 6930

Radu, I., 2014. Augmented reality in education: A meta-review and cross-media analysis. Personal and Ubiquitous Computing. 18(6), 1533–1543.

DOI: https://doi.org/10.1007/s00779-013-0747-y

Retelsdorf, J., Köller, O., Möller, J., 2014. Reading achievement and reading self-concept – Testing the reciprocal effects model. Learning and Instruction. 29, 21–30.

DOI: https://doi.org/10.1016/j.learninstruc.2013.07.004

Rogerson-Revell, P.M., 2021. Computer-assisted pronunciation training (CAPT): Current issues and future directions. RELC Journal. 52(1), 189–205.

DOI: https://doi.org/10.1177/0033688220977406

Rolf, K.R., Slocum, T.A., 2021. Features of direct instruction: Interactive lessons. Behavior Analysis in Practice. 14(3), 793–801.

DOI: https://doi.org/10.1007/s40617-021-00613-4

Romano, M., Díaz, P., Aedo, I., 2023. Empowering teachers to create augmented reality experiences: the effects on the educational experience. Interactive Learning Environments. 31(3), 1546–1563.

DOI: https://doi.org/10.1080/10494820.2020.1851727

Safar, A.H., Al-Jafar, A.A., Al-Yousefi, Z.H., 2017. The effectiveness of using augmented reality apps in teaching the English alphabet to kindergarten children: A case study in the state of Kuwait. Eurasia Journal of Mathematics, Science and Technology Education. 13(2), 417–440.

DOI: https://doi.org/10.12973/eurasia.2017.00624a

Sagin Simsek, C.S., 2008. Students' attitudes towards integration of ICTs in a reading course: A case in Turkey. Computers & Education. 51(1), 200–211.

DOI: https://doi.org/10.1016/j.compedu.2007.05.002

Saito, K., 2013. Reexamining effects of form-focused instruction on L2 pronunciation development: The role of explicit phonetic information. Studies in Second Language Acquisition. 35(1), 1–29.

DOI: https://doi.org/10.1017/S0272263112000666

Salvetti, F., Bertagni, B., 2019. Virtual worlds and augmented reality: The enhanced reality lab as a best practice for advanced simulation and immersive learning. Form@re - Open Journal per La Formazione in Rete. 19(1), 242–255.

DOI: https://doi.org/10.13128/formare-24796

Scarparolo, G.E., Hammond, L.S., 2018. The effect of a professional development model on early childhood educators' direct teaching of begin-

ning reading. Professional Development in Education. 44(4), 492–506.

DOI: https://doi.org/10.1080/19415257.2017.1372303

Schlesinger, N.W., Gray, S., 2017. The impact of multisensory instruction on learning letter names and sounds, word reading, and spelling. Annals of Dyslexia. 67(3), 219–258.

DOI: https://doi.org/10.1007/s11881-017-0140-z

Schmitt, N., Schmitt, D., 2014. A reassessment of frequency and vocabulary size in L2 vocabulary teaching. Language Teaching. 47(4), 484–503.

DOI: https://doi.org/10.1017/S0261444812000018

Şimşek, B., Direkçi, B., 2023. The effects of augmented reality storybooks on student's reading comprehension. British Journal of Educational Technology. 54(3), 754–772.

DOI: https://doi.org/10.1111/bjet.13293

Squire, K.D., Jan, M., 2007. Mad City Mystery: Developing scientific argumentation skills with a place-based augmented reality game on handheld computers. Journal of Science Education and Technology. 16(1), 5–29.

DOI: https://doi.org/10.1007/s10956-006-9037-z

Steen-Utheim, A.T., Foldnes, N., 2018. A qualitative investigation of student engagement in a flipped classroom. Teaching in Higher Education. 23(3), 307–324.

DOI: https://doi.org/10.1080/13562517.2017.1379481

Stevani, M., Tarigan, K.E., 2022. Need analysis of dyslexia students in English reading comprehension instructions. Journal of English Education and Linguistics Studies. 9(2), 327–352.

DOI: https://doi.org/10.30762/jeels.v9i2.520

Sungkur, R.K., Panchoo, A., Bhoyroo, N.K., 2016. Augmented reality, the future of contextual mobile learning. Interactive Technology and Smart Education. 13(2), 123–146.

DOI: https://doi.org/10.1108/ITSE-07-2015-0017

Tigra Live Animations, 2017. Hippo Magic (Version 5.0.2) [Mobile app]. Google Play Store. Available online: https://play.google.com/store/apps/details?id=org.liveanimations.hippomagic&hl=en&gl=US

Tobar-Muñoz, H., Baldiris, S., Fabregat, R., 2017. Augmented reality game-based learning: Enriching students' experience during reading comprehension activities. Journal of Educational Computing Research. 55(7), 901–936.

DOI: https://doi.org/10.1177/0735633116689789

Torgesen, J.K., 2002. The prevention of reading difficulties. Journal of School Psychology. 40(1), 7–26.

DOI: https://doi.org/10.1016/S0022-4405(01)00092-9

Tunmer, W.E., Hoover, W.A., 2019. The cognitive foundations of learning to read: a framework for preventing and remediating reading difficulties. Australian Journal of Learning Difficulties. 24(1), 75–93.

DOI: https://doi.org/10.1080/19404158.2019.1614081

Tzima, S., Styliaras, G., Bassounas, A., 2019. Augmented reality applications in education: Teachers point of view. Education Sciences. 9(2), 99.

DOI: https://doi.org/10.3390/educsci9020099

Uz Bilgin, C., Tokel, S.T., 2018. Facilitating contextual vocabulary learning in a mobile-supported situated learning environment. Journal of Educational Computing Research. 57(4), 930–953.

DOI: https://doi.org/10.1177/0735633118779397

Vate-U-Lan, P. (editor), 2012. An augmented reality 3D pop-up book: The development of a multimedia project for English language teaching. 2012 IEEE International Conference on Multimedia and Expo; 2012 Jul 9–13; Melbourne, VIC, Australia. IEEE: New York. p. 890–895.

DOI: https://doi.org/10.1109/ICME.2012.79

Vellutino, F.R., Tunmer, W.E., Jaccard, J.J., et al., 2007. Components of reading ability: Multivariate evidence for a convergent skills model of reading development. Scientific Studies of Reading. 11(1), 3–32.

DOI: https://doi.org/10.1080/10888430709336632

Venäläinen, J., 2023. 10: Getting texts done: Affective rhythms of reading in quantified academia. Affective capitalism in academia. Policy Press: Bristol. pp. 196–215.

DOI: https://doi.org/10.51952/9781447357865.ch010

Wallace, R.M., 2003. Online learning in higher education: A review of research on interactions among teachers and students. Education, Communication & Information. 3(2), 241–280.

DOI: https://doi.org/10.1080/14636310303143

Weerasinghe, M., Biener, V., Grubert, J., et al., 2022. VocabulARy: Learning vocabulary in AR supported by keyword visualisations. IEEE Transactions on Visualization and Computer Graphics. 28(11), 3748–3758.

DOI: https://doi.org/10.1109/TVCG.2022.3203116

Wilson, K., 2016. Critical reading, critical thinking: Delicate scaffolding in English for Academic Purposes (EAP). Thinking Skills and Creativity. 22, 256–265.

DOI: https://doi.org/10.1016/j.tsc.2016.10.002

Wu, H.K., Lee, S.W.Y., Chang, H.Y., et al., 2013. Current status, opportunities and challenges of augmented reality in education. Computers & Education. 62, 41–49.

DOI: https://doi.org/10.1016/j.compedu.2012.10.024

Wu, Q., 2015. Designing a smartphone app to teach English (L2) vocabulary. Computers & Education. 85, 170–179.

DOI: https://doi.org/10.1016/j.compedu.2015.02.013

Yang, G., Badri, M., Al Rashedi, A., et al., 2018. The role of reading motivation, self-efficacy, and home influence in students' literacy achievement: A preliminary examination of fourth graders in Abu Dhabi. Large-Scale Assessments in Education. 6(1), 10.

DOI: https://doi.org/10.1186/s40536-018-0063-0

Zhao, Y., Zheng, Z., Pan, C., et al., 2021. Self-esteem and academic engagement among adolescents: A moderated mediation model. Frontiers in Psychology. 12, 690828.

DOI: https://doi.org/10.3389/fpsyg.2021.690828

Zhou, Y., Wei, M., 2018. Strategies in technology-enhanced language learning. Studies in Second Language Learning and Teaching. 8(2), 471–495.

DOI: https://doi.org/10.14746/ssllt.2018.8.2.13