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Sociocultural Cognitive Development (SCCD) of language learning in an extended reality environment

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Abstract The present technology provides multifaceted aid in education through teaching and learning. Synchronous and asynchronous teaching-learning became popular with regular add-on updates with the required amendments, as f2f teaching has restrictions. One such advancement is extended reality (XR) technology in language learning, which has accelerated since the pandemic. Despite the increased use of technology in teaching and learning, few studies concerning sociocultural cognitive development (SCCD) are available. Therefore, this study is concerned with the possibility of Vygotsky's sociocultural grounds in extended reality (XR) being used as an enriched resource in English language learning (ELL). On this occasion, the study reviews recent scholarly articles on XR tools in language learning to determine how the sociocultural components of XR contribute to potential learning in achieving its outcomes.

Keywords: culture, interactions, language learning, sociocultural, XR-technology

1. Introduction

The use of technology is constantly evolving with new inventions. Augmented reality, which provides an immersive experience using 360-degree cameras, is one such feature that has found its way into education. The study by Asratie et al. (2023) reveals that topical technological inventions make EFL learners available to new opportunities and develop communicative competence within and outside the classroom. The term XR was first used in the 1960s when Wyckoff, a photographer, used it to describe the silver halide XR film he developed to capture light. The use of XR technology in education is a new perspective, and this study examines the sociocultural components in the XR environment that stimulate interactions and develop cognition. This study looks at the social surroundings in the XR environment and the social elements that create social interactions. It also explores how the XR environment influences culture by presenting learning material and its possible impacts on computer culture.

XR is a term that encompasses all the different types of virtual reality, augmented reality, and mixed reality tools. These tools have a range of applications, from medical and security fields to education and knowledge. AR tools connect historical places with their cultural details, enhancing comprehension as the tools provide language through context (Kuru & Zeybek, 2022). In mixed reality, virtual and real worlds combine to create new environments (Mills et al., 2022). Akdere et al.'s (2021) pre- and post-survey results claimed that EFL learners increased their cultural knowledge and intercultural sensitivity during VR simulations. Using AR in classroom teaching provided immediate feedback that resulted in better pronunciation and enhanced speaking skills with instant feedback (Hu et al., 2022). CALL and AI support provide corrective feedback in second language learning (Klimova & Pikhart, 2022), and new VR systems provide haptic feedback in producing digital text (Mills et al., 2022). Binhomran and Altalhab (2021) and Yılmaz et al. (2022) experiments with young EFL learners proved that AR implementation positively increased motivation, comprehension, retention, and vocabulary. However, Radianti et al. (2020) claimed that the VR language learning research has yet to be fully scaled.

This study uses Vygotsky's sociocultural theory to examine how XR technology can improve language learning. This study explores various aspects that aid in improving thought processing, such as the zone of proximal development, other knowledgeable persons, scaffolding, and language learning in the XR environment. Several studies have shown that XR technology's immersive features enhance learning by facilitating remote social presence and interactions. The 3D technology and high proximity to the reality of XR tools increase interactivity during online classes and meetings via Google Meet and Zoom. According to Wang et al., 2022, speaking competence needs context, exposure, and practice, so cultural immersion in language learning is important. Therefore, this study aims to discuss how XR technology can enhance cognitive development in language learning and the ubiquitous use of XR technology as a cultural artifact.

2. Literature Review

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As part of fast-moving technology, the pandemic introduced the artificial window concept of Argo design to simulate real-life work environments. Several technological inventions have paved the way between the digital and natural worlds. The EdTech sector provides students with immersive learning, formal education, and life-long learning for personal improvement, making learning more engaging and exciting. Bright students can understand and keep the information in memory for a long time. In contrast, slow learners cannot retain and recall the information they learn because they cannot focus continuously. Visual learning is one of the best solutions for them to watch a process instead of reading and getting more impact. The crucial feature of VR technology is learning by visualizing complex concepts and visual components (Kluge et al., 2023).

Figure 1 represents the beginning of the digital technology era and how research brought about innovative developments that have become a reality. VR was the first innovation that led to MR and augmented reality. The success of VR has expanded to various fields. The latest addition is 5D VR technology. VR gaming is interactive, with 3D effects and graphics that make it immersive. Pico Neo 2 Eye VR provides a convenient way to practice interview skills. Gestures such as waving hands and moving avatars stimulate a social environment. According to Jakub Flotynski (2020), touchscreen-enabled interactions such as gestures, stretching, sliding, rotating, scrolling, disappearing, and turning around help users recognize details such as age and gender. Additionally, Google Poly is a platform that allows users to create, share, and view multimedia panoramas. Viewers can access additional information through videos or photospheres, but questionnaires and gaming elements are unavailable. Among the 900 ready-made VR journeys, nine are generative representation learning objects.

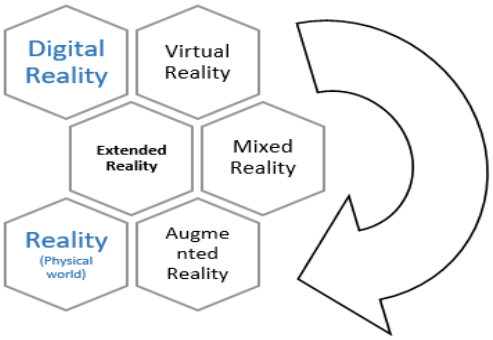

Figure 1 Transformation of Digital Reality into Reality.

Several technological tools use various aspects of augmented reality, mixed reality, and extended reality to improve the user experience. AR technology superimposes digital content in the real world, and some examples of AR tools include Google Glasses, AR Glasses, and Google's SkyMap app constellation. Mixed reality, on the other hand, combines digital and real-world elements, and Microsoft's AltSpace VR social VR platform is an example of this technology. WallaMe is an application that allows users to create, hide, and share text messages. AR Cloud Technology, Google's ARCore, and Apple's ARKit are some of the most popular AR tools available today, and they offer high-quality experiences that can significantly improve the user experience.

ChronoOps is an AR game that helps learners improve their English language proficiency using green technology. Moreover, HELLO is an AR-enhanced language learning application that combines conventional technology with AR to create a context-based learning environment for EFL users. Teachers can upload assessments and learning resources to HELLO's learning management system (LMS), and students can access them through U-browser, U-Speaker, U-Test, and U-QR codes. Rosetta Stone is the first and most popular CALL software for learning languages, with a comprehensive curriculum of 25 languages. Mondly, a Romanian EdTech company, provides tech-enabled language learning programs for 33 languages, including Mondly VR, which digitally places an AR teacher in the room for learners. ARientation and Augment are AR tools that allow students to scan their study-related texts using smartphones. At the same time, mobile games such as Surviving Alaska, Fukuchiyama Castle Rally in Japan, and Explorez can also help in language learning. Mixed reality combines real-world and digital elements through a 3D intuitive human environment. In contrast, extended reality is a blend of virtual and real-world or fully immersed digital experiences that are as authentic as real-world experiences. Google Cardboard VR viewer, 3D holograms, and avatars are examples of XR technology.

According to Wu et al. (2013), the effectiveness of augmented reality (AR) in education depends on how it is designed and implemented in different settings. Wu et al. (2013) categorized AR applications into three groups based on their features: fundamental individual resources, combined-open digital resources, and combined-open digital resources. Moreover, they divided AR educational applications into three types based on their role, location, and task. These applications can increase the engagement, contextualization, and authenticity of learning content, such as learning activities and context elements. Similarly, Karacan and Akoglu (2021) described AR applications as image-based, creation-based, and

markerless AR applications. Furthermore, Lai and Chang (2021) classified AR applications into visual, auditory, and kinesthetic applications, considering different learning styles.

2.1. XRs in language education

Disney researchers have created an augmented reality experience that allows children to bring their coloring books to life. With this technology, children can see the characters they are coloring projected in 3D on a bright screen. They can color the character, inspect their work, and watch the character move around in 3D. The texture of the 3D character matches the texture of the child's coloring lines, making it an interactive and immersive experience. Visual content such as images, videos, and gifs is more captivating than text-based content. Augmented reality enhances the engagement and immersion of images and video content, which leads to increased time spent using AR tools for products. The University of Virginia has also developed a VR classroom simulator. Trainee teachers can use this technology to practice and improve their teaching skills by managing students' behavior through feedback in an immersive virtual setting. The simulator features avatars that act like real students, providing a realistic and safe environment for teacher training.

According to a study by Beder (2012) in Sweden, vocabulary learning can be effective using AR technology, as it makes learning easier with 3D images and the spelling and pronunciation of words. Wen et al. (2023) developed an advanced tool called computer-assisted pronunciation training (CAPT) that provides visual feedback on pronunciation with lip shapes and tongue positions based on speaker articulation. One of the crucial concepts in immersive simulation-based training areas is learning objects (LOs), as stated by Friesen (2005). AR-based mobile-assisted language learning English materials designed by Liu and Tsai (2013) can help learners write English compositions. Furthermore, social-emotional learning, social skills, and social stories are crucial in special education curricula. Recent studies conducted by Huang et al. (2021) and Cai et al. (2021) suggest that incorporating XR (extended reality) tools in language learning can boost motivation and help learners achieve their objectives faster through situated learning.

The iVR environments are closely related to specific contexts, such as local experiences and locations in Australia. Pack et al. (2020) stated that engaging in a contextual setting while learning a language can reduce distraction. Yeh and Tseng (2020) developed an application to tailor their study to their needs and provide flexibility, as other applications may have strict rules and regulations for uploads. They suggested that organizing linguistic, multimodal, and semiotic resources is essential in developing ideas and interactions. Poor communication can reduce confidence and increase anxiety levels in English language learners, as noted by Kim et al. (2022). Kim et al. (2022) also found that communication confidence, L2 competence, motivation, sociocultural environment, sense of identity, and emotions are all factors that can motivate individuals to speak English. Kramsch (2004) noted that culture is immersed in target foreign language learning on a contextual basis. Peixoto et al. (2021) and Wang et al. (2022) both suggested that culture is a member of discourse communities. Asquith and Frazier (2022) found that students discovered the substantial value of using XR affordances in AR-based storytelling projects. According to the study of Aldossari and Alsuhaibani (2021), teachers understood that AR is valuable in elementary education, as it significantly improves language learning. According to Reinders et al. (2022) learning English outside the classroom provides new opportunities for the learning process without visiting any place and without any expenditure. Yuan (2022) found that effective learning material offers informal learning in support of formal learning. Yangın Ersanlı (2023) conducted an experimental study that revealed that students can acquire new words in AR-enhanced teaching. The study also showed that learning using AR applications is 'handy, anytime, anywhere' and improves language due to enhanced motivation in participant children. Learning vocabulary is more effective because the retention rate is greater than that of the conventional flashcard method. The essential reasons for adequate cognition using AR are based on qualitative interviews with Yangın Ersanlı (2023), including the visual appeal of 3D images, peer collaboration, effective interaction with digital objects, and gaming features. Dengel et al. (2022) suggested that XR provides immersive and interactive learning experiences with accelerated developments in the field. XR has the potential tool to learn with unparalleled opportunities as it captivates learners and deepens understanding. Mourtzis et al. (2022) suggested that XRs deliver personalized learning experiences and develop soft skills. Wang et al. (2022) and Wang et al. (2023) suggested that XR is a world-class educational resource that provides remote learning opportunities because of its immersive content authoring, with topics related to space, time, arts, geography, culture, and complex concepts. According to Young et al. (2023), the growing use of the XR in remote education contributes to remote learning. Norouzifard et al. (2023) reported that augmented reality positively affects language learning by promoting user interaction, resulting in deep vocabulary learning. Belda-Medina and Marrahi-Gomez (2023) found that learning with XR tools provides high learning effectiveness, resulting in learning permanency. XR-based language learning studies are helpful for discovery-based learning, AR books, and object modeling.

In a descriptive case study by Khoshnevisan (2020), the use of augmented reality (AR) tools enhanced idiom achievement. However, the same study also revealed that the idiomaticity of users did not improve with the use of AR tools. Multiple factors may be involved in the differences in the outcomes. A small sample study by Yengui and Stechert (2021) showed that activating necessary steps through AR can lead to efficient learning. However, a study by Koc et al. (2022) suggested that using AR has only a medium effect on improving English writing skills. Despite the substantial advantages of using extended reality (XR) tools, including AR, students and teachers face notable disadvantages. These include physical

ailments such as eye strain, motion sickness, and distorted or blurred vision, as well as psychological ailments such as feelings of detachment from reality, postvirtual reality (VR) sadness, and cyber addiction. Plastic VR glasses are more effective than cardboard VR glasses. User privacy is another significant issue, as XRs can collect personal data and capture users' thoughts and feelings. According to Restall et al. (2023), educational XR applications must provide students with autonomy to change options such as speed, repeat, and edit independently to adjust according to their requirements. The pedagogical fitness of the XR application is the most necessary characteristic feature that needs to be purposeful for the selected research. Furthermore, Belda-Medina (2022) noted that low image quality, cardboard AR glasses, limited hardware, and poor internet can be frustrating in most studies. Although XR is the future of the teaching-learning field, it has yet to become a common practice in university education due to the lack of evidence-based research, which is expensive to conduct.

2.2. Sociocultural Theory

Lev Vygotsky was a psychologist and social constructivist who developed the sociocultural theory of learners' cognition. According to Tzuriel (2021), this theory suggests that children's cognitive development occurs through mediation provided by adults who use instrumental and psychological tools. Children learn to use these tools while being guided by adults. Instrumental tools include machines and language, while psychological tools are strategies for thinking, rules, and mnemonics. The three main aspects of Vygotsky's theory are social interactions, language, culture, and other essential elements such as the zone of proximal development (ZPD), scaffolding by more knowledgeable individuals, culture-specific tools, social, cooperative, collaborative dialog, and reciprocal teaching (Cherry, 2022).

Social interactions are crucial in initiating human behavior and cognition in children. According to Vygotsky, cognitive functions develop in a child by gaining knowledge through social interactions. In contrast to Piaget's view of learning, Vygotsky emphasized that learning is part of the social context. Vygotsky's view of learning consists of two stages: the first stage involves social interaction, and the second stage involves the psychological construction of the learner. Speech mediates individual interaction, and it is a higher-order mental action if the social interaction involves a group, such as reasoning. High-standard psychological actions help reduce frustration and increase self-control, analysis, and creative thinking. Vygotsky claims that higher mental abilities are created only through interactions that influence an individual's psychological development because the cognitive functions are the products of social interaction. He emphasized that the community plays a vital role in meaning-making. Remembering is a process of meaning-making through social mediation. The two features of social dialog are intersubjectivity and scaffolding.

Biological cognition begins with the internalization of language. This means that thoughts start creating a new psychological operation before speaking and using intellectuality. According to Vygotsky, language is the best tool for humans. Children begin social speech (external communication) at the age of 2. From age 3, they start private speech (Piaget's egocentric speech), which is a way to direct a child's self to intellectual or cognitive development. Vygotsky believed that language and thought are two different systems, and they meet at the age of 3 to express inner speech. Inner speech occurs when social speech transitions into private speech. Private speech is no different from inner speech, but it indicates that inner speech has turned into private speech. This means that simultaneously, the individual's language combines with his or her thoughts to think verbally. Children with more private speech are more capable of social speech because private speech helps the cognitive process, allowing the child to think, solve problems, and develop their mind.

Children with more exposure to verbal exchange environments adopt private speech more quickly than do children with low verbal exchange. This is because of more cognitive and linguistic motivation in the environment. The more engagement in private speech, the more socially competent the child becomes. Silent inner speech starts at the age of 7. Through social participation, learning occurs in the zone of proximal development (ZPD). The ZPD is the place between the child's ability and the child's aided ability. Aided ability is the ability beyond the child's ability that comes from someone who can make the child able, where learners try to understand from more abled adults and try to adopt it. Vygotsky named this the adult More Knowledgeable Other (MKO). Appropriation is essential in the zone of proximal development.

Ness (2020) saw the ZPD as expanding the possibility of exploiting one's imagination, creativity, and emotions. When the learner's MKO is a teacher, professional subculture influences the learner's thinking. However, peer learning occurs in ZPD when less competent children learn from skilled peers. Scaffolding is a temporary help that can elaborate on the present skills and knowledge of the learner through scaffolding. Engagement, keeping the child's interest on the same track, support during difficulty, underlining the specific components, and demonstration are essential to expanding psychological skills, peer tutoring, and assistive learning in receptive learning.

Internal factors limit young children's memory, and culture determines what strategy to recall memory. Children in Western and European countries take notes to retain their memory. In contrast, before the invention of language script, societies carried pebbles and tied string knots to avoid forgetting things. Similarly, intellectual adaptation tools differ from culture to culture. MKOs transfer intellectual adaptation tools through culture, which are essential sources for cognition. According to Vygotsky, cognitive development depends on social interaction, so it differs from culture to culture. Sociocultural cognitive development (SCCD) initiates knowledge through social interactions through the guided learning of

ZPD. Intellectual adaptation tools differ from culture to culture, and learning is culture-dependent. Unlike Piaget's universal cognition, Vygotsky's cognition included society and culture.

Table 1 Notions of Vygotsky and examples.

ITEM	Aspects	NEEDED
	MKOs	peers, parents, adults, teachers, maids, caretakers, society, community, collaborative dialogs, and coaches.
	Instrumental tools	machines, language, thinking strategies, rules, and mnemonics, technology, computers, books, and internet.
	cognitive intelligence tools	problem-solving strategies, and reasoning.
	ZPD	creativity, play, emotions, cooperative learning, immersion, and collaborative learning.
	Cognition	thinking, reasoning, and remembering.
	learning	knowledge, problem-solving strategies, summarizing, guiding, encouraging, and instructing.
	Scaffolding	collaborative projects, and cooperative learning.
	reciprocal teaching	questioning, prediction, and clarification.
	mental functions	attention, sensation, perception, reasoning, and memory.
	social interactions	social presence to social actions.
	Culture	cultural values, and beliefs.

Learning is not limited to human applications alone. Siemens (2005) has shown that nonhuman applications can also connect sources of information. According to Vygotsky's theory, biological components are necessary for psychological development, but their impact is partially cultural. Lantolf and Thorne (2006) included augmented reality tools in cultural artifacts, activities, and concepts. Lantolf et al. (2015) express that sociocultural theory allows the human psychological system to work with cultural artifacts, activities, and concepts. In addition, Greenwood and Wang (2018) suggest that technology-enhanced language learning (TELL) provides new learning opportunities by enabling access, acquisition, and sharing, which fosters interaction and collaboration in learning.

3. Research Method

Extended reality (XR) can transform various industries, including education, health, and gaming. XR can motivate learners to retain information and continue their studies in language learning. This study aims to explore the sociocultural framework of XR technologies in language learning by analyzing 23 research studies on this topic from 2020 to 2023. This study will use bibliographic content analysis to evaluate previous studies based on XR affordances, social cognitive factors, and cultural influences. The primary focus is on the affordances of XR for English language learning, emphasizing Vygotsky's sociocultural theory. However, previous augmented reality (AR) studies have primarily relied on case studies to evaluate the effectiveness of various mobile technologies and AR products. As a result, there is a research gap regarding the theoretical support of cognitive models that help learners acquire linguistic expressions and vocabulary. This chapter reviews sociocultural theory and recent studies of XR from an English language learning perspective to determine how the sociocultural components of XR environments contribute to achieving learning outcomes.

4. Findings and Discussion

Language learning requires specific features such as engagement, immersion, collaboration, social interaction, remote presence, and communication. These features are crucial in the TESOL context, where authentic material and interactivity enhance EFL students' speaking competency. Interactivity is one of the essential features of language learning, where users actively participate in discussions, resulting in engagement. On the other hand, social presence is a passive version where users are only remotely present. Social presence is obligatory in online conferencing platforms such as Zoom, Microsoft Office, Google Meet, and social media networks. Before interactions, social presence undergoes multisensory experiences to interact with groups, leading to immersion. Fine-tuned and subtle interactions produce social fluidity with rich clarity.

Computer technology is a cultural tool (Mcleod, Jan 2024). Taguchi (2023) produced information on intercultural competence (Liaw, 2019), such as perspective-taking, empathy in culture, social initiative, and emotional balance through 360-degree VR videos to identify cultural practices. VR technology enhanced the ecological validity of the performance-based measure because of its realistic environment in intercultural learning. The VR simulations provide an opportunity to use the knowledge and skills gained. Compassion, broadmindedness toward uncertainty, respect for otherness, and awareness of communication are the cultural themes enhanced during research using XR technology and were analyzed by Taguchi (2023) to assess intercultural competency. The ability to recognize others' feelings, thoughts, and behavior. Mills et al. (2020) state that actional immersion motivates social initiation and interaction with engagement and involvement. AR can also produce learning material with a cultural context for clarity and quick understanding (Yangın Ersanlı, 2023). Saidin et al.'s (2015) study

showed that XRs stimulate learners' cognitive ability to focus more on language learning. Binhomran and Altalhab (2021) reported that AR benefits language learning by facilitating the learning process and providing rich cognition in learners, as learning is similar to acquisition. Haptic technology, multimodal exposure, and various learning materials in real-world contexts make self-expression possible by the learner (Pegrum, 2021). Taguchi (2023) claimed that a context-rich environment shapes embodiment cognition. Using XR tools (Mills et al., 2022), the cognition caused by media-based learning environments and multimodal textual production combines with sensorimotor visuals to create embodied cognition that aids in meaning-making during language learning.

The i-VR environment has a realistic language acquisition context with authentic language material that helps learners develop self-confidence and speaking competence in a fun environment during English language learning. A study by Berti et al. (2020) supported the idea that immersive environments provide personalized and contextualized learning opportunities. A study by Binhomran and Altalhab (2021) supported vocabulary enhancement in young EFL learners. The immersive study abroad experience of Wang et al. (2022) allowed interactive abilities in students. Pedagogical agents create social interactions during learning that aid in second language acquisition (Gu et al., 2023). The i-VR environments allow students to develop linguistic competence by learning vocabulary in contextualized settings. Virtual guides are instructional tools for MKOs. Students learn by analyzing text in a realistic environment using multimedia and embedded videos. This multimodal, embodied, experiential learning scaffolds meaning-making with an enhanced language learning environment and turns speaking into a social activity. The students were immersed in a multisensory experience with embedded resources in the video and the audio track at a speed of 145 words per minute. The presence of multimodal resources in the video wherever required for the contextualized environment, for example, swimming with sea lions in Australia with a background video of Australia. South Korean students enjoyed the experience of not traveling abroad by watching the 360-degree video.

The findings mainly relate to the essential aspects of Lev Vygotsky's theories, including social interactions, culture, and language. The social element of Lev Vygotsky exemplifies its existence on a broad spectrum concerning language learning by using XR technology. As mentioned in Table 1 the primary step in social interaction is social presence. It begins with social presence or social telepresence of users' attendance, which might be open presence or remote presence (social isolation). Social initiation is followed by social presence, leading to social engagement and social involvement through social interactions. Motivation created by XR tools is significant for social initiation in an online social environment. Consequently, the flow of social interactions becomes socially fluid and makes participants social actors. Social interaction is the combination of less intense social engagement and high-intensity social involvement. Although XR usage has multiple positive side effects, social challenges, and problems are some of the downsides of using social XR applications. Conversely, online social interactions may be verbal, e.g., dialog, or nonverbal, e.g., gestures influence the cognition process in language learning (Chen & Sevilla-Pavon, 2023). The everyday nonverbal interactions occur through eye contact, facial expression, and body posture, but in an online XR environment, they might include text, voice, video, image, emoji, or gif. In comparison, lip-syncing facial expressions and VR space with cross-cultural partners sponsored learner engagement. Embodied experience processes information during language learning. Among all the social components discussed, social interactions that bring social experience are the most important and influential elements that strengthen the learning process with the help of sub social components that occur before and after interactions. Social cues and inputs aid social engagement and involvement in learning and using social mechanics for easy social flow or behavior. Social virtual reality advances social representation and mediation skills in learners.

The practical strategies illustrated in Table 1 help to reach ZPD: scaffolding, apprenticeship, and reciprocal teaching. The XR environment is studied to determine how it presents culture and its effect on learning about it. On the other hand, learning using computer technology is a culture. In the former aspect, cultural and social factors influence the cognition process. Numerous quantitative experiments prove the positive impact of learning through sociocultural settings. Learning is culture-dependent; thus, learners learn differently in many cultures. Culture makes any content new with its regional, linguistic, and psycho-financial statuses, bringing new cultural learning. In a study by Taguchi (2023), XR tools improved intercultural mediation and competency through instruction so that the participants could observe cultural practices by reproducing cultural scenes and becoming aware of cultural differences. In the latter aspect, learning using technology is a present culture. After the pandemic, digital meetings became practiced in the work culture to frame a safety culture and laid-back task completion experience. Figure 2 illustrates the transformation through scaffolding techniques in the XR environment (Valjataga, & Pata, 2024). The ubiquitous use of virtual learning platforms in computer culture either results in the use of the same kind of intellectual adaptation tools or culture-blend adaptation tools to increase intellectuality. The byproduct of AR learning is culture; learners learn language in a cultural context, e.g., through native speech and historical details.

The contextualized environment, intrinsic motivation, and communication competence are the refined qualities that come under the zone of proximal development. In a sociocultural environment, the emotional feeling of presence and immersion in a contextual setting reduces distraction. EFL learners' speaking competency is supplemented with authentic material, interactivity, immersive, high fidelity, and real-world experiences, providing a more profound and richer immersive sensory experience in a virtual space through the fine-tuned features of XR technology. The multimedia resources embedded

in VR create multisensory involvement during learning. The multimedia objects are embedded as text, audio, or videos in virtual reality and connected to the context, creating contextual semiotic resources as input for learning. The timely and effective reality makes learning more enjoyable and effective. A positive effect on students' linguistic abilities and cognitive abilities is beneficial for enhancing learners' motivation. Virtual guides and personal digital assistants analyze the text in a realistic environment using multimedia and embedded videos. This multimodal, embodied, experiential learning, multisensory experience with embedded resources in the video and the audio tracks creates an enjoyable learning environment. Self-confidence, anxiety, and willingness to speak are the results of using XR technology during language learning. Learning the English language became fun and accessible through interactions using AR applications; importantly, AR technology has effectively improved grammar, learning processes, motivation, and engagement (Marrahí-Gomez & Belda-Medina, 2022), listening (Tai, 2022), sign-language learning (Westin et al., 2022), vocabulary (Lai & Chang, 2021), and speaking and pronunciation skills (Hu et al., 2022). Learning is not like textbook or notebook material but rather more like gaming, so the process naturally motivates learners. Interactions are reciprocal with teachers, peers, or any MKOs from Table 1, but AR learners can also interact with digital objects.

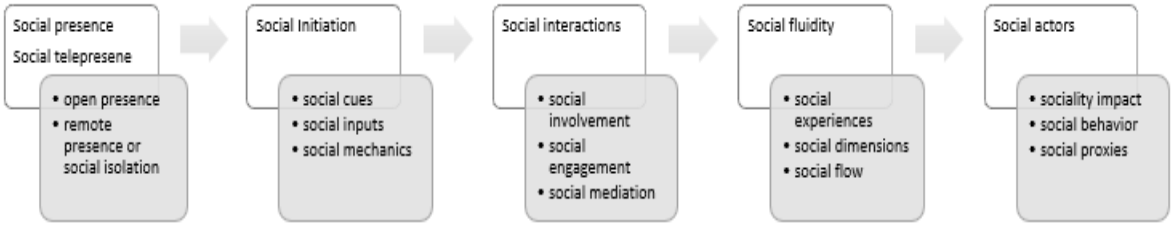

Figure 2 Formation of social interactions.

XR affordances provide scaffolding opportunities for learners to learn independently, i.e., they make the learners travel into the zone of learner ability. Mostly, MKOs guide learners to learn what they cannot learn independently. Here, the XR technology is a catalyst for learning, such as MKO; for example, it aids in creating a situation to discuss so that the participants can develop a rapport between them. XR provides options for the details of objects displayed to help learners develop self-scaffolding strategies. Visual realia, language in its culture, virtual gestures, movable graphic organizers, and completion through gaming sharpen soft skills.

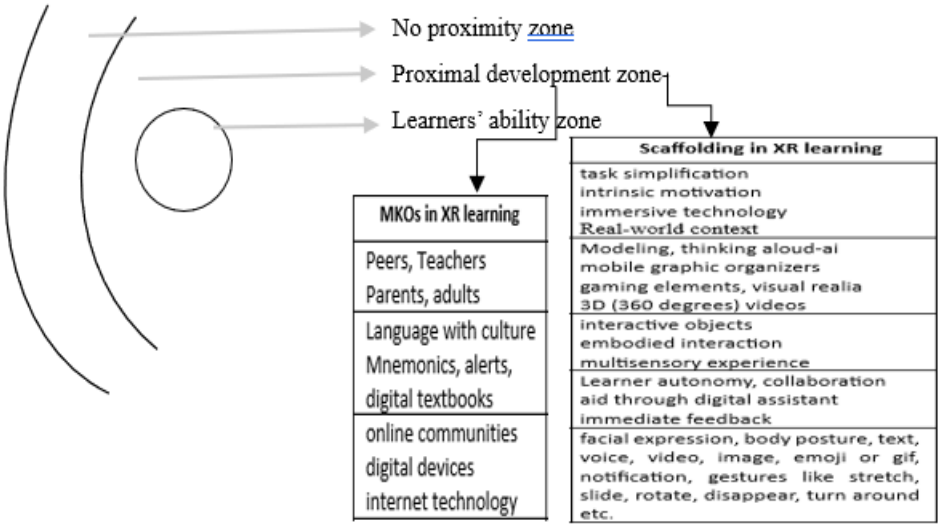

Figure 3 Scaffolding and MKOs in ZPD.

Scaffolding helps individuals achieve more profound knowledge; there are two types of scaffolding strategies: cognitive and metacognitive scaffolding strategies. There are two types of negotiation scaffolding (Shin et al., 2020): meaning-negotiation scaffolding (MS) and position-negotiation scaffolding (PS). They are used to solve complex problems in learning. Examples of some scaffolding strategies include Kruiper et al. (2022), who initiated joining a task, making the task easy, continuing the task, allowing the students to be under control, and learning during the execution of a task. The techniques that a teacher uses to achieve these scaffolding strategies include tapping prior knowledge, modeling, instruction, explanation, providing hints/feedback, verification, verbal participation, prompting questions, peer projects, thinking aloud,

reading-aloud, graphical representation, vocab starters, sentence starters, using visual aids, time to talk, and gradual release of responsibility. Figure 3 represents the scaffolding techniques gained through XR technology in language learning.

The XR is near-real virtuality. Despite XR being a cutting-edge technology, it is affordable and easy to use with a simple head-mounted display (HMD) where learners can watch a 3D environment in the virtual world that increases perception and interaction. Sociocultural cognitive development (SCCD) provides strong cognition through XR images and other objects, resulting in effective recall and permanent gain of language knowledge because the images are near-original. The results of XR in language learning also included a positive impact on learning and permanent vocabulary retention due to the use of powerful 3D videos and digital audio tracks. Comprehensively, learning is more common because the students are merely motivating and teachers are facilitators due to realistic simulations in the XR. The foremost exciting point is that the learners achieve the outcomes quickly as they like to continue learning by using the XR applications, as the XR environment is more dynamic, fun, and peer-participatory with rich learning experiences.

5. Final Considerations

The study concludes that the presence and association between Vygotsky's components and the use of extended reality enhanced the formation of cognitive development resulting in extended support for the process of language learning in which learner experiences of learning are wealthy, influential, and long-lasting due to social interactions with persons and objects, authentic language as the presentation is with culture and the powerful multimedia that acts as MKOs and provides scaffolding techniques to learners to retain cognitive knowledge. Social interaction is an example of behavioral theory. However, when the interaction is purposeful, such as language learning, it results in rich sociocultural and cognitive development (SCCD) due to various transformed scaffolding techniques involved in the zone of proximal development. The framework of online interactions is a complex but vibrant procedure that ensures rapid cognitive development. Another critical point is that ample research on vocabulary, motivation, and language learning processes through XRs is available online. However, fewer studies on meaning-making, listening, speaking, and pronunciation are available, and fewer studies on writing, sentence learning, and grammar are available. However, it is essential to conduct further research on the relationship between language and culture.

Ethical consideration

Not applicable.

Conflicts of interest

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