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The impact of immersive educational environments on productive and receptive vocabulary in dyslexic university students of EFL: A case study

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ABSTRACT

EN This study investigates the impact of Immersive Educational Environments (IEEs) on English vocabulary acquisition among university students with Specific Learning Disorders, particularly dyslexia. Grounded in Universal Design for Learning and the Italian Framework for Inclusive Language Education, the research combines inclusive pedagogical theory with innovative technological tools. A mixed-method case study was conducted at the University of Genoa, involving 92 students in an experimental online English course. Results revealed that IEEs enhanced learners' motivation, engagement, and lexical performance—particularly in vocabulary retention and contextual usage. Compared to traditional methods, immersive and multisensory environments provided higher accessibility and supported both receptive and productive vocabulary development. The study also highlights dyslexic students' specific needs, including preferences for visual, interactive content and structured, transparent instruction. While limitations exist, findings support IEEs as promising tools for inclusive language education, offering new pathways to address diverse learner profiles in higher education.

Key words: INCLUSIVE LANGUAGE LEARNING, EFL, IMMERSIVE EDUCATIONAL ENVIRONMENTS, VOCABULARY

ES Este estudio analiza el impacto de los Entornos de Aprendizaje Inmersivos (EAIs) en la adquisición de vocabulario en inglés por parte de estudiantes universitarios con Trastornos Específicos del Aprendizaje, en particular dislexia. Basada en el Universal Design for Learning y en el Marco Italiano para la Educación Lingüística Inclusiva, la investigación combina teoría pedagógica inclusiva con herramientas tecnológicas innovadoras. El estudio de caso, realizado en la Universidad de Génova con la participación de 92 estudiantes en un curso experimental de inglés en línea, mostró que los EAIs incrementaron la motivación, la participación y el rendimiento léxico, especialmente en la retención y el uso contextual del vocabulario. En comparación con los métodos tradicionales, los entornos inmersivos ofrecieron mayor accesibilidad y favorecieron tanto el desarrollo receptivo como el productivo del léxico. Asimismo, se identificaron las preferencias de los estudiantes con dislexia por contenidos visuales e interactivos y por una instrucción clara y estructurada. Aunque se reconocen algunas limitaciones, los resultados confirman a los EAIs como herramientas prometedoras para una educación lingüística inclusiva.

Palabras clave: APRENDIZAJE LINGÜÍSTICO INCLUSIVO, INGLÉS COMO LENGUA EXTRANJERA (EFL), ENTORNOS DE APRENDIZAJE INMERSIVOS, LÉXICO

IT Il presente contributo esplora l'impatto degli ambienti educativi immersivi sull'acquisizione del lessico inglese da parte di studenti universitari con disturbi specifici dell'apprendimento (DSA), in particolare con dislessia. A partire dalla teoria dello Universal Design for Learning e in base ai principi del Quadro Italiano per l'Educazione Linguistica Inclusiva, lo studio integra approcci pedagogici inclusivi con strumenti tecnologici innovativi. La ricerca si basa su uno studio di caso con 92 studenti, coinvolti in un corso online sperimentale di lingua inglese presso l'Università di Genova. I risultati mostrano come gli ambienti immersivi abbiano incrementato motivazione, partecipazione e competenze lessicali, soprattutto nella memorizzazione e nell'uso contestuale del lessico. Rispetto ai metodi tradizionali, l'approccio immersivo e multisensoriale ha garantito maggiore accessibilità e favorito lo sviluppo sia ricettivo sia produttivo del lessico. Lo studio evidenzia, inoltre, le preferenze degli studenti con DSA per contenuti visivi, multimediali e interattivi e per un'organizzazione didattica chiara e strutturata, confermando il potenziale degli ambienti immersivi per un'educazione linguistica inclusiva.

Parole chiave: APPRENDIMENTO LINGUISTICO INCLUSIVO, INGLESE COME LINGUA STRANIERA, AMBIENTI EDUCATIVI IMMERSIVI, LESSICO

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1. Introduction

Language acquisition poses significant challenges for individuals with dyslexia, largely due to socio-biopsychological factors commonly associated with this learning disorder. These factors include limited working memory, heightened anxiety, difficulty concentrating, and struggles with recognizing and distinguishing phonemes—and consequently, graphemes (Daloiso & Melero Rodríguez, 2016; Kormos & Kontra, 2018)—especially in opaque languages such as English. As a result, second language learning for dyslexic individuals requires targeted instructional strategies that support vocabulary retention, sound discrimination, and sustain motivation throughout the language acquisition process. Most scientific literature on these strategies primarily focuses on children and learners in compulsory education, with relatively little research on adult learners. However, higher education (HE) plays a pivotal role in both the social and personal development of students with dyslexia, whose learning is addressed within the broader framework of Special Educational Needs (SEN)—a label referring to educational support needs rather than students' personal traits. As Hartley (2015, p. 416) observes, HE provides a transformative experience, "enabling them to flourish and derive the benefits of participating in higher education." Moreover, the transition from high school to university represents a critical period for identity formation, requiring students to develop self-regulation and self-determination skills (Bellacicco, 2018). Higher education also significantly impacts career prospects. Although individuals with SEN experience a higher unemployment rate (46.2%) compared to those without SEN (25.9%), research from the Academic Network of European Disability indicates that completing an academic career improves their chances of securing employment and reduces the likelihood of experiencing discrimination (Bellacicco, 2018).

Over the past three decades, several international initiatives, including UNESCO's 1994 Salamanca Statement and the 2030 Agenda for Sustainable Development, have promoted inclusive and sustainable HE. These efforts have also encouraged research into the educational needs of individuals with dyslexia. Among the instructional approaches identified as effective, technology-related methods have gained increasing attention, particularly multisensory approaches that provide diverse input, stimulating multiple semiotic channels simultaneously (Ohene-Djan & Begum, 2008). One of the most innovative tools capable of effectively implementing the multisensory approach is Extended Reality (XR), specifically immersive educational environments (IEEs). These tools have demonstrated significant efficacy in language learning by providing contextual learning and promoting cross-cultural competence (Peixoto, 2021), enhancing intrinsic motivation (Kontra, 2019), facilitating the retention of new words and expressions (Chen, 2016; Cheng, Yang, Andersen, 2017), and improving overall vocabulary accuracy (Legault et al., 2019).

This paper explores the potentialities of IEEs for learners with dyslexia and presents the results of a case study investigating the impact of IEEs on English as a Foreign Language (EFL) vocabulary acquisition for university students with dyslexia. It first outlines the theoretical framework underpinning inclusive language learning theories, emphasizing the crucial role of technology in supporting vocabulary acquisition for this profile. It then presents findings from a case study involving Italian university students, demonstrating how IEEs can positively impact their vocabulary acquisition and overall language learning experience.

2. Vocabulary acquisition processes in dyslexic learners

Vocabulary has long been recognized as a fundamental component of language proficiency in foreign language or second language (L2) learning, as extensively documented in the literature (Read, 1988; Laufer, 1998; Schmitt, 2000; Meara, 2002). It plays a crucial role in both comprehension and production, serving as the basis for communication. However, studying vocabulary acquisition presents several challenges, including defining what constitutes a "word," addressing both denotative and connotative meanings, and fostering not only memorization but also the ability to use and master vocabulary across different dimensions—formal, structural, semantic, and metaphorical (Fontecha & Gallego, 2012).

Since the 1980s, L2 vocabulary research has distinguished two main types: receptive and productive vocabulary. Receptive vocabulary includes words that learners understand in written or spoken form, while productive vocabulary refers to words that they can actively use in speaking or writing. Typically, receptive vocabulary develops earlier and is larger in size (Nation & Meara, 2013). However, both are essential for language acquisition. As Nation and Meara highlight, vocabulary focus should be based on learner needs and the utility of words, often assessed through frequency and range. Schmitt (2008) identifies two primary goals: 1) vocabulary size, i.e., the number of words needed for comprehension, and 2) vocabulary depth, referring to

accurate and appropriate use of lexical items. This includes understanding meanings, recognizing collocations, and forming lexical associations.

While researchers largely agree on what learners should acquire in terms of vocabulary, approaches to teaching and learning vocabulary vary. A widely used method is *Meaning-Focused Input*, which promotes incidental learning through exposure to language. As Nation and Meara (2013) emphasize, such learning is cumulative and requires repeated encounters for deeper word knowledge. While effective for native speakers, L2 learners often benefit more from deliberate strategies like glossing, repeated exposure, and contextual practice (Nation & Meara, 2013; Schmitt, 2008). Alternatively, the *Meaning-Focused Output* approach centers on productive use through speaking and writing. Though more demanding, strategies like writing tasks, storytelling, role-play, and group work can support vocabulary development by fostering communication and contextual learning (Newton, 1995; Schmitt, 2008). Despite its challenges, this approach often leads to greater engagement, encouraging learners to practice outside the classroom and supporting informal learning (Pavesi & Ghia, 2020; Schmitt, 2008; Wang et al., 2015).

Regardless of type or approach, acquiring, storing, and using new vocabulary requires several cognitive functions such as memorization, word recognition and retrieval, and abstractness. For learners with dyslexia, thus, developing both receptive and productive vocabulary is particularly challenging due to multiple interrelated factors.

Firstly, difficulties in their first language can affect L2 vocabulary acquisition processes. Research indicates that dyslexic learners' challenges with L1 word decoding, phonological awareness, and dictation often hinder L2 acquisition. Additionally, accuracy and speed in L1 reading are strong predictors of L2 reading difficulties (Kirby et al., 2010; Kormos et al., 2019). Moreover, while L1 status is only an indicator and not a direct correlation, several studies have demonstrated that underdeveloped L1 word decoding negatively impacts L2 reading comprehension (Daloiso & Melero Rodríguez, 2016; Kormos & Kontra, 2018).

Biological and psychological factors also significantly impact the cognitive processes underlying L2 vocabulary acquisition. Dyslexic learners often have weak phonological awareness, making it difficult for them to recognize different phonemes and reproduce sounds. This challenge hampers the conversion of receptive vocabulary into productive vocabulary. Dyslexic individuals also struggle with discerning sounds and associating them with corresponding graphemes, particularly in opaque languages such as English and French (Lovegrove, 1991; Kirby, 2018). Additionally, dyslexic learners often have limited orthographic processing skills, which are essential for recognizing and using different orthographic units crucial for lexical development (Rakhlin, Cardoso-Martins, Grigorenko, 2013).

These linguistic challenges are often linked to bio-psychological factors such as underdeveloped working memory, limited executive functioning skills, and high levels of anxiety (Daloiso & Melero Rodríguez, 2016; Irshad et al., 2022). Studies (Kirby, 2018; Kormos & Kontra, 2018) have shown that dyslexic individuals often have underdeveloped working memory, making it difficult to store, retain, and retrieve information. Consequently, learners with dyslexia, particularly dyslexia, struggle to memorize new words and build receptive vocabulary, often resulting in a smaller L2 vocabulary compared to non-dyslexic individuals. Even when information is retained, individuals with dyslexia often have difficulties organizing and using it effectively due to, difficulties in abstract thinking, organization, and planning. Also, vocabulary acquisition is particularly affected by emotions; for this reason, learners with dyslexia's high levels of anxiety cause them to have an emotional barrier. In educational settings, anxiety is especially evident during reading tasks, such as timed assessments (Bellacicco, 2018; Cardinaletti, 2018). Although anxiety levels tend to decrease after compulsory schooling, university students with learning difficulties often exhibit higher vulnerability compared to their neurotypical peers (Carroll & Iles, 2006; Irshad et al., 2022; Staggini, 2024). This increased vulnerability leads to heightened social anxiety, lower self-esteem, and reduced language motivation, ultimately negatively impacting language performance.

While these key elements negatively impact L2 acquisition in dyslexic individuals, it is also essential to acknowledge positive influences such as creativity and visual thinking that are fundamental in developing productive vocabulary. Although defining creativity remains complex and recent studies (Erbeli, Peng & Rice, 2022; Gutiérrez-Ortega, 2023) indicate no significant differences in overall creativity between dyslexic and non-dyslexic individuals, it has been demonstrated that they often excel in specific categories of the construct of creativity, such as visuality, fluency, originality, and elaboration, particularly in adulthood. Studies using the Torrance Test of Creative Thinking and other models (Bigozzi et al., 2016; Chakravarty, 2009; Cockcroft & Harthill, 2004; Kapoula et al., 2016) have demonstrated that individuals with dyslexia generate numerous

original ideas, rely on visual memory and multimodal strategies as coping mechanisms, and exhibit original information processing.

Considering these key elements, researchers in inclusive language education and second language acquisition have developed various approaches that apply multimodal strategies, visual memory, motivation enhancement, and transparent, linear instructional designs to support learners with dyslexia, and learners with SEN in general. The following section will describe the inclusive teaching theories and approaches that have been used in the case study.

3. Inclusive language teaching theories and approaches

The concept of Inclusive Language Teaching refers to teaching strategies that make language learning accessible to all types of learners, regardless of their biological, socio-economic or cultural condition, thus including learners with dyslexia (Daloiso, 2012). Regarding this concept, various L2 acquisitional theories have been systematized, among them: Universal Design for Learning (UDL), and the Italian framework for Inclusive Language Teaching, both emphasizing a shift from product to process, attention to individual learners, multidimensional accessibility, and elimination of language barriers (Daloiso, 2012; Daloiso & Melero Rodríguez, 2016; Rose et al., 2006).

The Italian framework for Inclusive Teaching originates from 1990s psycholinguistics and teaching theory, which prioritized communicative competence over formal language aspects. Inductive methods, allowing learners to infer rules from examples, proved more effective as they engaged with the language process (Balboni, 2011). By the 2000s, research shifted focus from considering learners' need universal to acknowledging learner diversity across three macro areas: learning styles, cultural differences, and language differences. Although learning styles are debated (Panzavolta & Mori, 2019), their functional use remains crucial in inclusive teaching as they relate to different memorization processes and emphasize the importance of learners developing personalized strategies for language acquisition. Therefore, when teaching foreign languages from an inclusive and accessible perspective, educators should take into account the predominant learning styles of their students, especially those with dyslexia who often rely on non-verbal learning styles not commonly use in both compulsory schooling and Higher Education (Daloiso, 2012). As for cultural differences, this framework not only encourages respect for different cultures but also fosters curiosity and engagement with them, emphasizing multiculturalism and cultural competence, aspects that are often overlooked in language education (Caon et al., 2019; Daloiso, 2012). Since culture is deeply intertwined with language, effective strategies for inclusive learning in mixed-ability classrooms—where students have varying language proficiency levels—include simplified written tests (beneficial for foreign students as well), alternative evaluation methods (often used for students with dyslexia), and progressively challenging activities that gradually increase in complexity, enabling students to develop skills in a structured manner (Kormos & Kontra, 2018).

Regarding multidimensional accessibility, the Italian Framework for Inclusive Language Teaching asserts that learners with specific language needs should be provided with resources that ensure physical, psychological, and methodological access to language learning. Physical accessibility involves removing barriers such as architectural obstacles that hinder school entry or materials like books and handouts that contain visual barriers (e.g., fonts unsuitable for dyslexic learners). Psychological and cognitive accessibility addresses the cognitive overload experienced by students with special needs, whether due to limited L2 comprehension (as seen in foreign students) or distinct brain functioning (as in students with dyslexia). Teachers should implement accessible strategies to alleviate this cognitive burden and foster motivation (Kontra, 2019). From a methodological perspective, educators should prioritize accessible and inclusive teaching strategies such as formative communicative approach, which has proven effective, as it emphasizes communication, pragmatics, and learners' bio-psycho education over grammar and rigid structural aspects (Kormos & Kontra, 2018; Kontra, 2019). This method assumes that language acquisition is best achieved in authentic communicative settings, where learners can apply their skills contextually, adapting to different speakers, registers, and situations. Accordingly, teachers should use authentic materials and prioritize contextualized input. Additionally, since language learning enhances relational abilities by exposing learners to diverse cultures and communication styles, educators should also focus on soft skills and metacognitive competence (Daloiso, 2012). Another crucial component is phonological competence, particularly for students with dyslexia, who often have underdeveloped phonological awareness and difficulty processing phonemes, and consequently graphemes. Teaching L2 sounds explicitly helps these learners recognize and use them

accurately. However, as with grammar, phonological instruction should not rely on repetitive listening and memorization, but should instead incorporate authentic materials like recorded conversations, debates, speeches, and audiovisual content (films, TV series) or immersive scenarios that provide phonetic examples in real-life contexts (Daloiso, 2012; Staggini & Cersosimo, 2021).

The Universal Design for Learning Theory is grounded on similar assumptions. The UDL model originated from Universal Design, a discipline initially studied and developed in architecture to create accessible environments, particularly for individuals with sensory disabilities. By applying this concept of "accessibility" to education, in the late 1990s, Rose and Meyer at the Center of Applied Special Technology (CAST), in the USA, established a theoretical framework to enhance educational inclusivity through technology (Rose et al., 2006; Cumming & Rose, 2022). Grounded in cognitive science and neuroscience, UDL examines how the brain learns by recognizing, processing, and valuing patterns and abstract concepts (Cytowic, 1996). For example, reading requires pattern recognition in words and structures, but individuals with dyslexia may have atypical recognition systems, impacting their ability to process information (Rose, 2006). Additionally, the affective networks, which regulate emotions and motivation, also influence learning, and impairments in these networks can hinder a student's ability to engage, prioritize, and focus (Balboni, 2011; Cumming & Rose, 2022). CAST's framework is structured around three core principles: multiple means of representation, expression, and engagement. The first principle emphasizes providing information through varied modalities to accommodate diverse learning needs, including students with disabilities such as blindness or deafness. The second principle focuses on multiple means of expression, recognizing that students differ in their capacity to navigate learning environments and demonstrate knowledge, necessitating flexible assessment and instructional approaches. Lastly, the engagement principle highlights the need for diverse motivational strategies, considering that students have varying preferences in learning environments—some thrive on novelty, while others require stability (Kontra, 2019; Rose, 2006).

These principles have been operationalized through 31 checkpoints (See Fig. 1) published by CAST in 2018, offering guidelines to enhance accessibility in teaching (Nave, 2021). Moreover, CAST's recommendations extend to comprehension strategies, emphasizing the role of context, multimodal aids, and alternative forms of expression to accommodate students with diverse linguistic and cognitive profiles. Ultimately, UDL promotes technological integration to ensure equitable access to learning for all students. Among the teaching strategies and tools promoted and suggested by CAST, Technology Enhanced Learning (TEL) and other technological tools are indeed described as very effective and productive in enhancing both educators' lesson planning and teaching, by optimizing their time and resources, and students' learning processes, by providing them with assistive technology that compensates their impairments, and by offering diverse multimodal learning input.

To summarize, while the Italian framework for Inclusive Language Education stems from psycholinguistic and communicative language teaching, prioritizing pragmatic and communicative competences, UDL originated from architecture and design and is based on cognitive sciences, focusing on how the brain processes and organizes knowledge. Moreover, while UDL is a general educational framework applicable across disciplines, the Italian one was specifically developed to address dyslexic students' dyslexia language needs. Despite these slight differences, both the theories align in their commitment to inclusive and adaptive education, promoting learner diversity, accessibility, and multimodal approaches to teaching. Their complementary nature suggests that integrating both perspectives can enhance inclusive language education by combining neurological insights with practical, language-specific pedagogical strategies. For this reason, the case study presented in this paper adopts both the theories, combining the technological-driven nature of UDL, and the practical pedagogical approach to grammar and vocabulary acquisition of the Italian Framework.

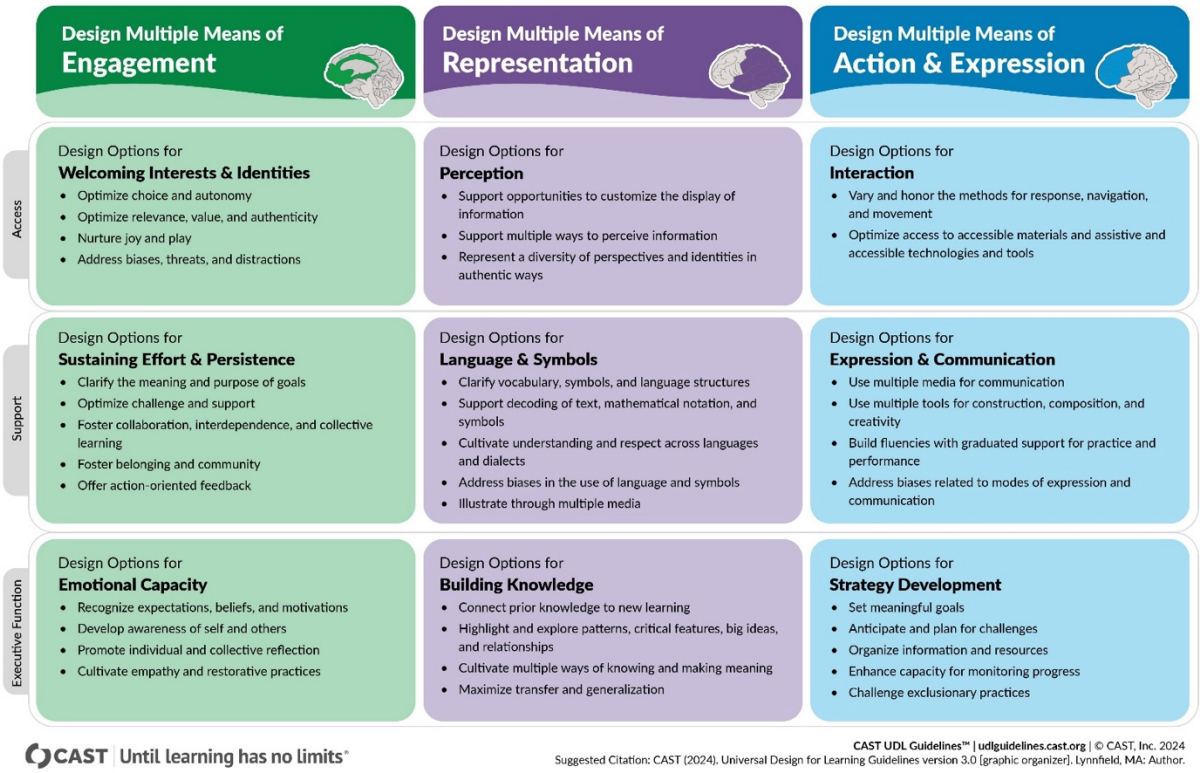

Figure 1. CAST's guidelines for inclusive and accessible teaching.

3.1. Technology enhanced learning as a supporting teaching approach

As previously mentioned, technology plays a pivotal role in Inclusive Language Education, especially within UDL. Technology may serve as an assistive instrument, compensating for several types of impairments: text-to-speech software for blind or visual-impaired individuals, more readable and accessible fonts for dyslexics, or automatic captioning for deaf or hard of hearing individuals. However, according to CAST, general technological tools—those not specifically designed to support individuals with disabilities or other conditions—can also significantly contribute to learning (Cumming & Rose, 2022). While assistive technology (AT) primarily compensates for students' underdeveloped abilities or lack of competencies due to special educational needs, more conventional technological tools can serve as learning aids or as educational platforms for technology-enhanced learning. TEL is a pedagogical approach that relies primarily on digital tools to support learning (Bayne, 2015). The term TEL is frequently used interchangeably with e-learning or computer-based learning and refers to the intersection between education and digital technology with the aim of improving students' learning experiences (Bayne, 2015). Specifically, TEL encompasses a range of approaches that use technology to support learning, particularly within HE, where it was initially developed. In 2009, the Higher Education Funding Council for England identified three key benefits of TEL: efficiency, enhancement, and transformation. TEL has been shown to improve the effectiveness of UDL, as technology-rich environments offer flexibility, adaptability, and multimodality. In this regard, Burgstahler (2008, p. 29) highlights that:

> Flexible components are built into digital materials to benefit students with learning disabilities; with attention issues; with behavioral problems; or with physical or sensory disabilities. They also benefit those who are learning a new language; who have attention deficits; or who have other characteristics that make taking notes, reading, understanding auditory information, paying attention, handwriting, or spelling difficult.

Conversely, traditional paper-based materials, such as textbooks and worksheets, struggle to align with the three principles of UDL (Dinmore, 2014; Edyburn, 2010). Notably, integrating TEL with UDL has

proven beneficial for all students, regardless of their abilities or disabilities. "Embedding these principles at the initial stage of the design process is a crucial element in mainstreaming inclusive teaching and learning principles for all students" (Dinmore, 2014, p. 34).

Furthermore, TEL has demonstrated effectiveness in language learning. In the early 2000s, researchers began exploring the impact of the Internet on language acquisition, identifying numerous advantages. One major benefit is that digital technologies provide access to diverse learning materials, including both traditional and multimedia resources—such as articles, books, websites, and social media, alongside videos, podcasts, films, and TV series (Chapelle, 2007). Additionally, TEL positively affects the affective filter in language learning, as it creates a low-anxiety environment where students can practice at their own pace (Pino, 2008). Moreover, learners requiring repeated input or reinforcement activities can benefit from computer-based learning, which allows unlimited practice opportunities. Therefore, flexibility and adaptability stand out as two of TEL's most valuable features (McDonough, 2001; Pino, 2008). Another crucial advantage of TEL is its role in fostering intercultural competence—an often-overlooked yet essential component of language learning. Digital tools, particularly the Internet, have significantly expanded opportunities for students to engage with speakers from diverse cultural backgrounds, facilitating natural and spontaneous exposure to the target language both in formal and informal educational settings. Studies have demonstrated that TEL effectively enhances intercultural competence by enabling learners to interact with native speakers or other language learners across different cultural contexts, both through synchronous and asynchronous communication (Trepule et al., 2015). Digital learning, finally, is particularly beneficial for students facing physical, economic, or logistical barriers to education, including those unable to commute, students with chronic illnesses requiring hospitalization, and individuals from disadvantaged economic backgrounds. Thus, TEL, together with other innovative approaches, is effective as an inclusive educational model (Benigno et al., 2018; Rahman & Dar, 2022).

3.2. The multi-sensory approach for inclusive language education

As previously discussed, students with dyslexia often experience challenges in visual and auditory perception, and have different brain functioning, which affect their language processing. While compensatory tools are valuable aids, and technology in general provides them with different types of media and input, it is also essential to adopt teaching approaches that actively stimulate their cognitive processing. One of the most effective methods for enhancing perception and language processing is the multi-sensory approach which aligns with the principles of UDL and the guidelines of the Italian Framework for Inclusive Language Education (Ahmad et al., 2012; Moustafa, 1999).

The multi-sensory approach, also known as the Visual, Auditory, Kinesthetic, and Tactile (VAKT) approach, originated in the 1950s and was systematically developed in the 1980s (Murphy, 1997). It involves the use of multiple sensory modalities—such as seeing, hearing, touching, and moving—to reinforce learning. Research has demonstrated that engaging learners through various sensory channels enhances memory retention, text-decoding, and comprehension, aspects that are often underdeveloped in students with dyslexia. For example, Graham and Freeman (1986) developed a spelling strategy that required students to say, write, trace, and recall words, primarily relying on visual and tactile memory. Similarly, Sparks and Miller (2000) suggested integrating tactile and kinesthetic techniques into foreign language learning, advocating for practices such as pronouncing syllables while writing them to strengthen spelling and pronunciation. Crombie (2000) further emphasized that multi-sensory learning supports students with dyslexia by ensuring that no single learning channel is excluded. The author highlighted the importance of differentiation—offering varied input to maximize the potential of all learners—and recommended strategies such as using pictures, word cards, videos, and audio materials to improve vocabulary, reading, and pronunciation skills.

Since the 2000s, researchers have increasingly recognized the potential of integrating technology with the multi-sensory approach to support learners with SEN, with dyslexia specifically (Ahmad et al., 2012; Ohene-Djan & Begum, 2008). Digital tools can easily provide multi-sensory input, combining auditory, visual, and tactile activities in a single platform. For instance, Crombie (2000) highlighted the effectiveness of text-to-speech and voice-to-text software for spelling and pronunciation practice.

Moreover, interactive multimedia resources—such as videos, animations, and graphics—have been shown to enhance reading comprehension and language acquisition by engaging multiple senses simultaneously. Gamification has also emerged as a powerful tool within the multi-sensory approach. The Dyslexia Activity System (DAS) in the UK, for example, provides interactive learning environments for children

with dyslexia through activities like word-image associations, drag-and-drop exercises, and short videos, all of which have been shown to enhance memory and motivation (Ohene-Djan & Begum, 2008).

More recently, Virtual Reality (VR) has been recognized as an effective medium for language learning, as it immerses students in a simulated environment where they can interact with objects and use multimodal and kinesthetic strategies aligned with multi-sensory principles (Kurniawati et al., 2020; Peixoto et al., 2021). The next section will explore the role of Immersive Reality Resources in Inclusive Language Learning, examining their application in the teaching of English as a Foreign Language for dyslexic students.

In conclusion, the multi-sensory approach provides effective strategies for supporting students with dyslexia by engaging multiple sensory modalities to enhance language processing and comprehension. Its integration with technology further amplifies its benefits, offering interactive and adaptive learning experiences that cater to diverse needs. As advancements in digital tools and immersive environments continue to evolve, they hold great potential for fostering inclusive language education.

4. Immersive Educational Environments

Immersive environments are computer-generated 3D simulations that vary in their degree of virtuality. The modern concept of virtuality is directly connected to the concept of *Virtual Reality* (VR), which was introduced by Lanier in the 1980s to describe simulated three-dimensional environments that users perceive as real. Until recently, VR has often been used as a broad term encompassing various forms of immersive realities (LaValle, 2023). However, scholars argue that this usage is inaccurate and instead advocate for the term *Extended Reality* (XR) as a more appropriate umbrella term (Doolani et al., 2020). XR encompasses all real and virtual environments combined and consists of VR, AR, and Mixed Reality (MR) as well. While AR retains a stronger connection to reality, VR is highly immersive, creating experiences that feel distant from the physical world. Any immersive environment, either AR or VR-based, should provide a certain degree of *immersion* and *presence*. Recently, scholars have made a clear distinction between these two concepts. Immersion refers to the level of sensory engagement provided by an immersive system—essentially, the degree of sensory fidelity. In contrast, presence is a subjective experience, where users perceive themselves as being inside the virtual environment. This perception is reinforced by the way the human sensory system responds to virtual elements and interacts with them (Berkman & Akan, 2018)

These environments have broad applications, spanning industries such as marketing, advertising, medicine, and space engineering. One of the most rapidly growing fields is education, where immersive technologies are leveraged to create Immersive Educational Environments (IEEs). IEEs provide fully interactive, multisensory learning experiences that foster engagement and active participation. These environments align with principles of inclusive language theories, which emphasize the cognitive benefits of stimulating multiple senses simultaneously—especially for learners with dyslexia (Mulders et al., 2020; Peixoto et al., 2021). Research suggests that IEEs improve knowledge retention, comprehension, and engagement (Clarke et al., 2008; Mulders et al., 2020). IEEs provide multimodal input, multisensory stimulation- fundamental for the application of the multisensory approach; foster engagement and motivation together with lifelong learning (Mulders et al., 2020); and support active learning and task-based learning (Peixoto et al., 2021). When referring to language learning in particular, IEEs have been studied to be very beneficial (Chen, 2016; Cheng et al., 2017; Legault et al., 2019; Staggini & Cersosimo, 2021). IEEs provide situated learning (Dawley & Dede, 2014) aligning with constructivist teaching theories by immersing learners in realistic language scenarios. Instead of rote memorization, students acquire language skills through practical application, fostering communicative and pragmatic competencies. Consequently, cultural competence is enhanced, as IEEs allow learners to experience cultural environments virtually. As Peixoto and colleagues (2021, p. 48958) state, IEEs "[...] allow the freedom and opportunity to recreate real world circumstances and places of cultural importance for the user to be immersed without the expense needed for an educational trip."

By simulating multilingual and multicultural contexts, IEEs promote multilingualism and improve L2 vocabulary competence through exposure to both oral and written language, leading to better retention and accuracy (Cheng et al., 2017; Legault et al., 2019). These aspects also support inclusivity, as students from diverse backgrounds can access culturally enriched learning experiences. Furthermore, IEEs captivate learners by immersing them in interactive language environments, significantly boosting engagement and motivation (Dawley & Dede, 2014). Peixoto and colleagues (2021, p. 48960) emphasize: "The high levels of motivation and satisfaction shown by users when using iVR certainly contribute to a significant increase in the very levels of learning efficacy and success."

For students with dyslexia, motivation and engagement are critical, as they often struggle with low self-esteem and learning anxiety. Research indicates that VR and AR technologies can provide significant benefits: "Some forms of virtual reality, for example, augmented reality, keep the students busy [...] they get interaction with the content; they amuse during learning and make the learning process easy" (Bjekić, Obradović, & Bojović, 2020, p. 40).

IEEs help learners with dyslexia by presenting content in an engaging, interactive format. Studies show that AR and VR-based learning enhances attention and improve working memory, making learning more efficient (Rodríguez-Cano et al., 2021). Additionally, IEEs have potential in improving dyslexic learners' ability to decode and reproduce letters as well, supporting them in both reading and speaking tasks (Bhatti et al., 2020). In summary, while research on IEEs is still emerging and mainly focuses on children as learners, studies have shown that these environments boost motivation and engagement, support memory retention, and enhance vocabulary acquisition through interactivity, multimodality, and multisensory input, promoting inclusive language learning practices.

5. The case-study

This study stems from the need to apply existing research on the benefits of VR and immersive environments for language learners to adult learners with dyslexia—an often-overlooked profile. By doing so, it aims to bridge a gap in recent studies. The case study explores two key research questions: (1) What are the educational needs of university students with dyslexia learning English? (2) Do IEEs positively impact vocabulary acquisition in these learners, as they do for dyslexic children? The main reasons why university students were targeted are because English proficiency at the B1 level for BA's degree students and B2 level for MA's degree students is a requirement in the Italian Higher Education System and research (Bellacicco, 2018; Cardinaletti, 2018) shows that dyslexic students face significant difficulties in passing these exams and in improving their language performance due to previous difficulties, high levels of anxiety, difficulties in decoding academic texts, and different learning styles that are often ignored by lecturers.

In order to answer these questions, mixed-method research strategies—explorative surveys, performance tests, and satisfaction questionnaires—were used to collect data. The research consisted of two main phases: gathering data about university students with dyslexia's needs, expectations, former school backgrounds, bias, and language difficulties; and administering an experimental online immersive course specifically designed on the data previously gathered. The experimentation occurred between 2022 and 2024 and involved the students at the University of Genoa: 720 students (666 students without dyslexia and 54 students with dyslexia) participated in the first phase; and 92 dyslexic students took part in the second phase. In the next sections, both phases' methods and data will be described in detail, with a special focus on the performance tests assessing vocabulary acquisition. Finally, the results will be discussed, highlighting the pedagogical role of IEEs.

5.1. Preliminary study: Students with dyslexia's profiling data

During the experiment's first phase, participants' educational needs were analyzed through a questionnaire administered to both students with dyslexia (N=54) and neurotypical students (N=666) to explore potential differences. All participants had failed the B1-level English exam at least once, as the survey assessed the students' feedback, needs and opinion about the university's mandatory recovery course.

The questionnaire was available in both Italian and English, though all students chose the Italian version. It included 21 items in five sections: (i) personal data (e.g., L1, degree program, language background); (ii) course organization (clarity, transparency, duration); (iii) exercises and usability (effectiveness, clarity, platform accessibility); (iv) graphic design and readability; and (v) content and engagement (interest, usefulness, motivation). The structure was based on the Italian accessibility framework (Caon et al., 2019; Daloiso, 2012) and UDL principles, assessing transparency, multimedia integration, and engagement. Data was analyzed through descriptive and statistical methods (Levène, T-tests, and Cohen's d where applicable). Regarding personal data, most participants were women (65.8%), aged 21–25. The majority spoke Italian as their first language (94.3%), followed by Spanish (2.1%), French (1.1%), Arabic (0.8%), Chinese (0.7%), Portuguese (0.4%), and others (0.1% each).

Item 2, focusing on past language-learning difficulties, is a particularly revealing data. It showed that 68.61% (494 students) had experienced challenges, while 31.39% (226 students) had not. Among students with dyslexia, 85.2% reported difficulties, compared to 67.3% of neurotypical peers. A chi-square test

confirmed a significant association (χ^2 = 7.446, p = 0.006), with Cramér's V (V = 0.102, p = 0.006) indicating a mild but meaningful link between dyslexia and language learning struggles.

For course organization (ii), 30% of students with dyslexia had trouble with complex instructions and were three times more likely to report difficulties in decoding texts. While 76% of all students approved of the course length, 43% of dyslexic students preferred shorter, more digestible lessons. On exercises (iii), 82% found them useful overall, but 33% of dyslexic students disagreed. Text-heavy exercises were problematic for 60% of students with dyslexia, versus only 15% of neurotypical students.

Significant differences emerged in layout and readability (iv), especially in items 7 (Cohen's d = 0.316), 8 (d = 0.383), and 10 (d = 0.297), reflecting dyslexic students' greater need for structured, transparent teaching. Item 15 (d = 0.417) underscored challenges with Moodle layout, spacing, and fonts. Item 17 confirmed specific issues: 31.48% of dyslexic students struggled with formatting and font size, versus 13.23% of neurotypical students who reported no issues.

In terms of content and engagement (v), while not statistically significant, descriptive data indicated the importance of images and videos for dyslexic students' comprehension (items 6, 16). Additionally, 64% of dyslexic students favored gamified and interactive content to support focus, compared to 28% of students without dyslexia.

In conclusion, the educational needs analysis confirms that students with dyslexia face more difficulties in understanding content, maintaining focus, and engaging with tasks than their peers. There is a notable association between dyslexia and language learning struggles. Moreover, visual design and digital readability are key factors, though multimedia aids help dyslexic students contextualize L2 content, poor layout and formatting can act as barriers.

5.2. The online experimental course: participants and design phase

Based on the above-described analysis of needs and with the aim to explore the potentialities of IEEs for vocabulary acquisition in students with dyslexia, an experimental online intensive B1 English course was designed for University of Genoa students who had not passed the mandatory proficiency exam. Open to all enrolled students with a dyslexia certification, the course was developed in collaboration with the university's Disability and Learning Disorders Office and the language centre, which provided data on students needing support. Eligible students were invited via email and posters, and participation was voluntary. A total of 92 students enrolled, split into an experimental group (52 students) and a control group (40 students). Due to high dropout rates, only 24 students completed the experimental course and 15 the control course. The only variable between the two groups was the use of IEEs (via *ThingLink*) for the experimental group, while the control group engaged with traditional non-immersive materials.

A three-unit online recovery course was structured around the theme of travel, a highly engaging topic (Diadori et al., 2009). The theoretical framework followed Online Education Design principles, ensuring accessibility and effectiveness. The course focused on:

- Unit 1 (London): Functional, grammatical, and lexical skills, including present simple vs. present continuous, expressions of courtesy, and British English.
- Unit 2 (Dublin): Descriptive skills, past tense distinctions, and vocabulary related to memory and personal experiences.
- Unit 3 (New York): Future tenses, conditional forms, vocabulary related to plans, expectations and desires, and American English exposure.

Each unit emphasized written and oral comprehension, integrating multisensory learning in line with UDL principles. The course incorporated authentic materials, and flexible and customizable resources, ensuring accessibility for students. The total duration of the course was about 25 hours over four weeks, divided into: 6 hours of instructional delivery; 11 hours of structured activities; 8 hours of individual study. Each module included: an introductory video and descriptive text; grammar and vocabulary lessons; interactive activities (immersive for the experimental group, traditional for the control group); writing tasks in discussion forums; self-reflection questionnaires on study strategies and progress; and finally, satisfaction surveys and performance tests. The experimental group engaged with *ThingLink*-based immersive environments, enhancing engagement through interactive 360° visuals and gamified learning, while the control group followed a more traditional approach. However, both courses presented clear and systematic layouts, readable

fonts, and a clear module structure to accommodate dyslexic students' need for structured, redundant, and transparent learning.

5.2.1 Instruments: Immersive Educational Environments

The immersive scenarios in the experimental course were created using *ThingLink*, a platform that supports interactive experiences across PC, tablets, and mobile devices, offering medium-low immersion. When used with headsets, it enables a medium-high level of immersion, simulating a Virtual Reality experience. *ThingLink* allows the integration of diverse resources, such as 360° images, infographics, guided tours, and VR content, with additional features introduced in 2023.

For the experimental group, explorable 360° images were used, sourced from Street View Download 360, ensuring high-definition representations of real-world locations. These images were uploaded to *ThingLink* and paired with on-site audio recordings from YouTube, featuring 3D sound effects to enhance immersion and multisensory input. Since continuous background audio can sometimes hinder learning (Dhimolea et al., 2022), students could pause playback as needed. *ThingLink* also supports interactive tags, enabling text and multimedia integration (audio, video, images); embedded web content (e.g., British Council, Cambridge resources); scenario-based activities; and guided tours. The experimental online course was organized into a structured sequence that combined entry-level assessment, instructional delivery, and reflective practice. It begins with an introductory phase, where participants first complete a survey designed to profile their expectations, needs, and difficulties, followed by an entry-level test made up of progressively challenging questions to assess their starting competence. Once these initial steps are completed, learners can access the three learning modules, each of which follows the same progression. After an introductory video accompanied by a short descriptive text, so to mix multimodal and multisensory input, students engage with communicative and grammatical content whose main aim was to practice vocabulary. Each module also includes two sets of digital activities, consisting of reading comprehension and use of English exercises specifically designed to test both receptive and productive vocabulary. In the experimental course these activities are embedded in immersive scenarios, while in the control group they are delivered in a list format on Moodle. Learners then complete a writing task in a dedicated forum to test their productive vocabulary competence. Each module concludes with a short satisfaction survey and a performance test aligned with the objectives of the unit. The course ends with a final satisfaction survey and a comprehensive test assessing the knowledge acquired throughout the program, with a specific focus on both receptive and productive vocabulary. Learners who successfully complete all stages receive a statement of attendance, formally recognizing their participation (See Appendix A).

In the experimental course, scenarios functioned as gamified virtual escape rooms, where students unlocked progress by answering quiz questions based on completed activities (See Figure 2). The interface used color-coded symbols for navigation:

- Red → Scenario introduction and cultural video
- White → Additional textual and cultural insights
- Numbered icons → Sequential learning activities
- Green key → Final quiz unlocking the next scenario. If it was incorrect, *ThingLink* provided hints, or students could seek support from a tutor.

Each immersive scenario was explorable, which in itself guaranteed multisensory learning by combining spatial navigation with multimodal content. IEEs were built around authentic materials, where every video or audio resource was accompanied by corresponding images and written text. To further guide learners' comprehension, visual hierarchy was created through the use of color-coded text, italics, and boldface. In addition, the *ThingLink* platform provided integrated assistive technologies—such as speech-to-text software, automatic translation, Pictionary, and other accessibility tools—that reinforced the multisensory design. This combination of immersive, multimodal exploration and assistive features not only fostered inclusivity but also proved particularly beneficial for students with dyslexia, who could process, connect, and retain information more effectively when supported by multiple input channels.

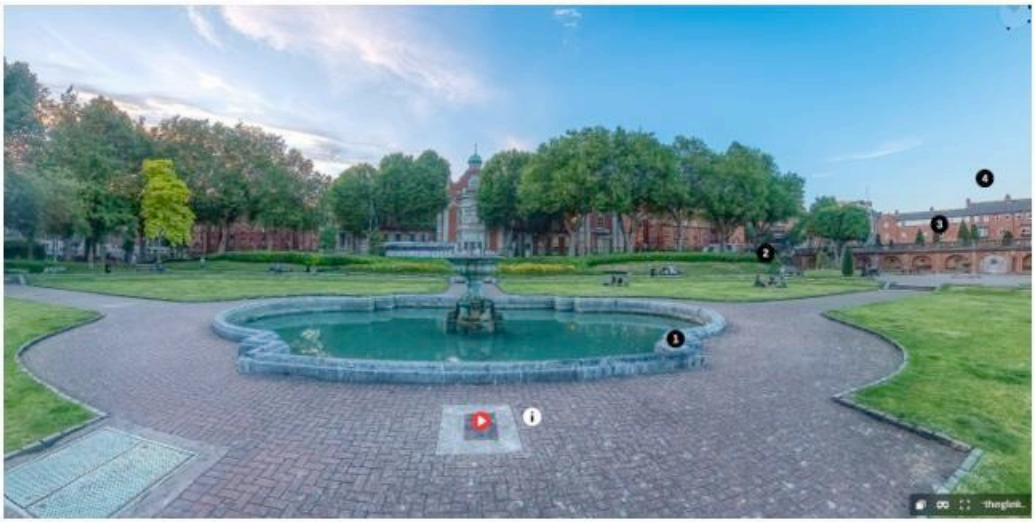

Figure 2. One of the immersive scenarios specifically designed for the online inclusive EFL course of the experimentation.

6. Assessing vocabulary learning: a mixed-methods data analysis

At the end of each module, students were requested to complete a writing task and take a performance test to assess productive and receptive vocabulary. Writing tasks were based on simple prompts concerning personal experiences in the present, in the past, and in the future, so as to explore learners' productive vocabulary. In order to do that, an assessment rubric was designed. It was based on several parameters: clarity, topic coherence, complexity, register, use of linkers, grammar correctness, detailed descriptions, and logic coherence. For the first four parameters, a maximum of 1 point was given. For the rest, a maximum of 2 points was given. For each task, the maximum total score could be 12. Receptive vocabulary, on the other hand, was tested by use-of-English exercises and reading tasks with cloze tests, included in the final performance test. This included 25 items testing reading comprehension, grammar, listening, and use of English. To analyze all the items, qualitative and quantitative methods were used, including descriptive and statistical analysis—Wilcoxon tests and the Mann-Whitney U test for independent samples, mainly.

Let us start by analyzing the overall performance of both groups. To assess whether immersive environments positively impacted learning outcomes, we compared the experimental and control groups (Table 1). The lowest initial test score was recorded by a participant in the experimental group (4.40/30), whereas in the control group, the minimum score was 6.00/30. However, in the final test, the lowest score was from the control group (14.60/30), while the minimum in the experimental group was slightly higher (15.93/30). This suggests that the average progress between the two tests was greater in the experimental group. Regarding the highest scores, both groups achieved a maximum of 29.75/30 in the initial test. However, in the final test, the highest score in the control group decreased to 28.60/30, while the experimental group reached a perfect 30/30. The most notable difference is in the mean scores. The control group had a lower starting average (17.07/30) compared to the experimental group (18.76/30). This trend continued in the final test, with average scores of 20.73/30 in the control group and 23.26/30 in the experimental group, indicating a greater improvement in the experimental group.

Table 1
Descriptive analysis of the final performance test scores

Group	Minimum	Mean	Std. Dev	25th perc	Median	Max
Control Group (T0)	6.00	17.07	5.22	14.35	17.02	29.75
Control Group (T4)	14.60	20.79	4.72	17.60	19.60	28.60
Experimental Group (T0)	4.40	18.76	6.50	14.83	18.23	29.75
Experimental Group (T4)	15.93	23.26	4.32	18.90	23.17	30

To further verify these findings, non-parametric Wilcoxon tests were conducted on both groups. Statistical analysis confirmed that the experimental group showed greater improvement.

6.1. Receptive vocabulary data analysis

Beyond overall performance, we examined the specific test items assessing lexical competence and receptive vocabulary in the final test. Specifically:

- Items 1, 2, 3 → A2-level reading comprehension exercise with multiple-choice questions;
- item 7 → B1-level matching exercise (definitions-words);
- Item 11 → B1plus-level "Use of English" exercise with selection of the correct word;
- Item 15 → B2-level matching exercise (words-context);
- items 20, 21, 22 → B2 plus-level reading comprehension exercise with multiple-choice questions.

Statistical analysis did not identify any significant differences. However, descriptive analysis highlighted interesting data. Table 2 shows the mean scores per Item:

Table 2
Descriptive analysis of the final performance test items regarding receptive vocabulary

Item	Max points	Experimental group's mean	Control group's mean
1	1	1	1
2	1	0.63	0.60
3	1	1	1
7	2	1.72	1.39
11	3	2.67	2.27
15	1	1.95	1.87
20	1	0.67	0.60
21	1	0.71	0.47
22	1	0.54	0.53

With the exception of items 1 and 3, where all participants answered correctly—likely due to these items being at an A2 level and therefore manageable for all students—the experimental group achieved higher average scores across all other lexical competence items. This suggests that immersive environments contribute positively to lexical acquisition. In particular, the experimental group outperformed the control group in items 7, 11, and 15, which were English exercises specifically designed to assess students' ability to infer meaning and use vocabulary in context. These exercises were better performed by the experimental group, confirming that visual contextualization and engaging, interactive educational environments significantly support students with dyslexia in decoding texts and understanding nuanced meanings. The results also indicate that the immersive and visually enriched environment helped these students not only grasp new vocabulary more effectively but also apply it accurately within appropriate contexts. This aligns with

existing research underscoring the benefits of multi-sensory learning for dyslexic students, particularly in the realm of receptive language skills.

Moreover, in the final reading comprehension assessment, which featured texts at a B2 level of proficiency, the experimental group demonstrated superior reading skills despite the increased difficulty. They performed better in decoding unfamiliar words, matching definitions and contexts to appropriate vocabulary, and in understanding the general meaning of complex texts. These findings reinforce the research hypothesis, as the quantitative analysis confirms that the use of IEEs not only boosts lexical competence but also enhances overall reading comprehension.

6.2. Productive vocabulary data analysis

To assess productive vocabulary, Mann-Whitney U tests were conducted on the three writing tasks scores of both groups. Additionally, a qualitative analysis was conducted.

To begin, descriptive analysis shows that the overall average scores are higher in the experimental group (except for writing task n.3 as one participant of the experimental group decided to write song lyrics instead of coherently answering the prompt). To determine whether there is a statistically significant difference in the distribution of each numerical variable (evaluation criteria) between the two groups, Mann-Whitney U test for independent samples was conducted. If the p-value is below 0.05, the null hypothesis is rejected (the distributions of evaluation criteria scores are equal in both groups) concluding that the distributions are significantly different. We are going to focus on task 1, as the majority of participants completed it, so it is more reliable.

The analysis identified significant differences in the four evaluation criteria (see Appendix B): vocabulary complexity; use of textual linkers; accuracy of descriptions; and textual coherence. The final results indicate a statistically significant advantage for the experimental group, further supporting the research hypothesis that IEEs positively influence student performance.

To further explore these findings, we conducted a qualitative content analysis within our mixed-method research framework. Writing Task 1, which involved self-presentation, hobbies, and abilities, was completed by the majority of students in both groups. However, 20 out of 24 students in the experimental group completed the task, compared to only 8 out of 15 in the control group, indicating higher engagement from the experimental group. Notable differences emerged between the two groups' writing performances: students in the experimental group produced longer and more complex texts, incorporating intricate grammatical structures such as hypothetical sentences, superlatives, and comparatives. They also included more personal details, showing higher levels of descriptive accuracy and vocabulary complexity—further confirming the results of the quantitative analysis.

Writing Task 2, which required describing a meaningful memory, was stimulating for both groups. However, only 33.3% of the control group completed the task, compared to 66.7% of the experimental group. While control group students demonstrated a relatively good level of grammatical accuracy, the experimental group once again stood out for producing more elaborate texts and for their willingness to experiment with new vocabulary.

Writing Task 3, which focused on future plans, expectations, and desires, proved challenging for both groups. Nevertheless, 16 out of 24 students in the experimental group completed the task, while only 3 out of 15 students in the control group did so. This suggests a significant difference in motivation levels and highlights the greater difficulty experienced by the control group when dealing with abstract or future-oriented writing tasks.

It is important to note that higher levels of motivation—particularly intrinsic motivation—emerged among the students in the experimental group. Many of them expressed a strong willingness to learn English and other languages as a means of broadening their knowledge and fulfilling aspirations such as traveling abroad [e.g., S.15, experimental group: *"I like studying English. My dream is to travel around the world, I would like to know all of the planet"*; S.16, experimental group: *"One of my goals is to travel around the world and maybe, one day, move to England or the U.S.A., in Atlanta"*; S.3, experimental group: *"I chose to study languages because I love helping people to communicate and understand each other"*; S.17, experimental group: *"I would like to see the world in order to find my way"*].

By contrast, students in the control group did not express any language-learning motivation in any of the three tasks, with the exception of Student 3. However, this case reflected an instrumental rather than an intrinsic orientation [S.3, control group: *"I'm studying it (English) because I need a university degree in order to work in Italian public schools"*].

Overall, the writing tasks revealed consistently higher levels of engagement, linguistic experimentation, and expressive ability among students in the experimental group. Their increased task completion rates, more complex language use, and greater willingness to elaborate on personal experiences suggest that immersive and visually rich learning environments foster not only improved lexical and grammatical skills but also enhance students' confidence and motivation to express themselves in writing. These qualitative observations support and reinforce the findings from the quantitative analysis, confirming the positive impact of immersive educational environments on the written performance of students, particularly those with learning differences.

7. Results and discussion

This study examines how immersive educational environments influence motivation and vocabulary acquisition in university students with Specific Learning Disorders. The main key findings are about: specific language needs, and the impact of IEEs on motivation, and consequently, on word retention and lexicon acquisition. About language needs, the study reaffirmed the persistent challenges that students with dyslexia face in L2 learning, including difficulties with comprehension, independent study, and text readability. Compared to their neurotypical peers, these students struggled more with processing instructional content, highlighting the need for greater structure and clarity in teaching materials. A lack of systematic instructional design was identified as a key factor contributing to these challenges in both native and foreign language acquisition. Additionally, among these learners' needs, the preference for multimedia materials relying on visuality stands out clearly. Also, readable content and flexible learning environments are identified as relevant. About the L2 learning process, the case-study shows that the experimental group showed higher motivation, engagement, and completion rates compared to the control group. The immersive course was perceived as more transparent, structured, and accessible, enhancing student participation. About vocabulary, students in the experimental group produced more complex and diverse lexical structures, demonstrating enhanced vocabulary retention. Motivation played a crucial role in lexical acquisition, reinforcing findings in previous studies (Fontecha & Gallego, 2012).

It is important to highlight that, while this study provides valuable insights into the impact of immersive educational environments on university students with dyslexia, certain limitations should be acknowledged, and areas for improvement identified. A key limitation is the small sample size, with only 39 out of 92 participants completing the study, restricting the generalizability of findings. Another challenge is the lack of standardized profiling tools for dyslexic students, making cross-context comparisons difficult. Existing diagnostic categories often overlook comorbidities like ADHD or anxiety, which significantly affect learning. Refining classification methods would improve data accuracy and deepen our understanding of individual learning needs.

Building on these insights, future research should involve larger samples and examine additional language competencies, including listening comprehension, grammar accuracy, and intercultural competence. Given the interconnected nature of language skills, a holistic approach would provide a more comprehensive understanding of how IEEs influence overall proficiency. Another area of exploration is whether IEEs have the same impact in different languages. Since English is an opaque language with complex spelling and pronunciation rules, it would be valuable to study whether immersive environments yield similar benefits in transparent languages like Italian or Spanish. Early findings suggest comparable advantages, but further research is needed.

Lastly, the study raises questions about applying inclusive course design strategies beyond dyslexic students. Learners with visual impairments, for example, face similar challenges in digital learning environments. Investigating cross-disability accessibility strategies could contribute to more universally inclusive online learning models.

In conclusion, this study represents an early effort to explore how to enhance language performance—particularly vocabulary acquisition—through a holistic approach. By addressing the specific needs of university students with dyslexia and designing a flexible, accessible online environment, this research demonstrates how IEEs can cognitively stimulate learners, increase motivation, and ultimately improve the language learning process.

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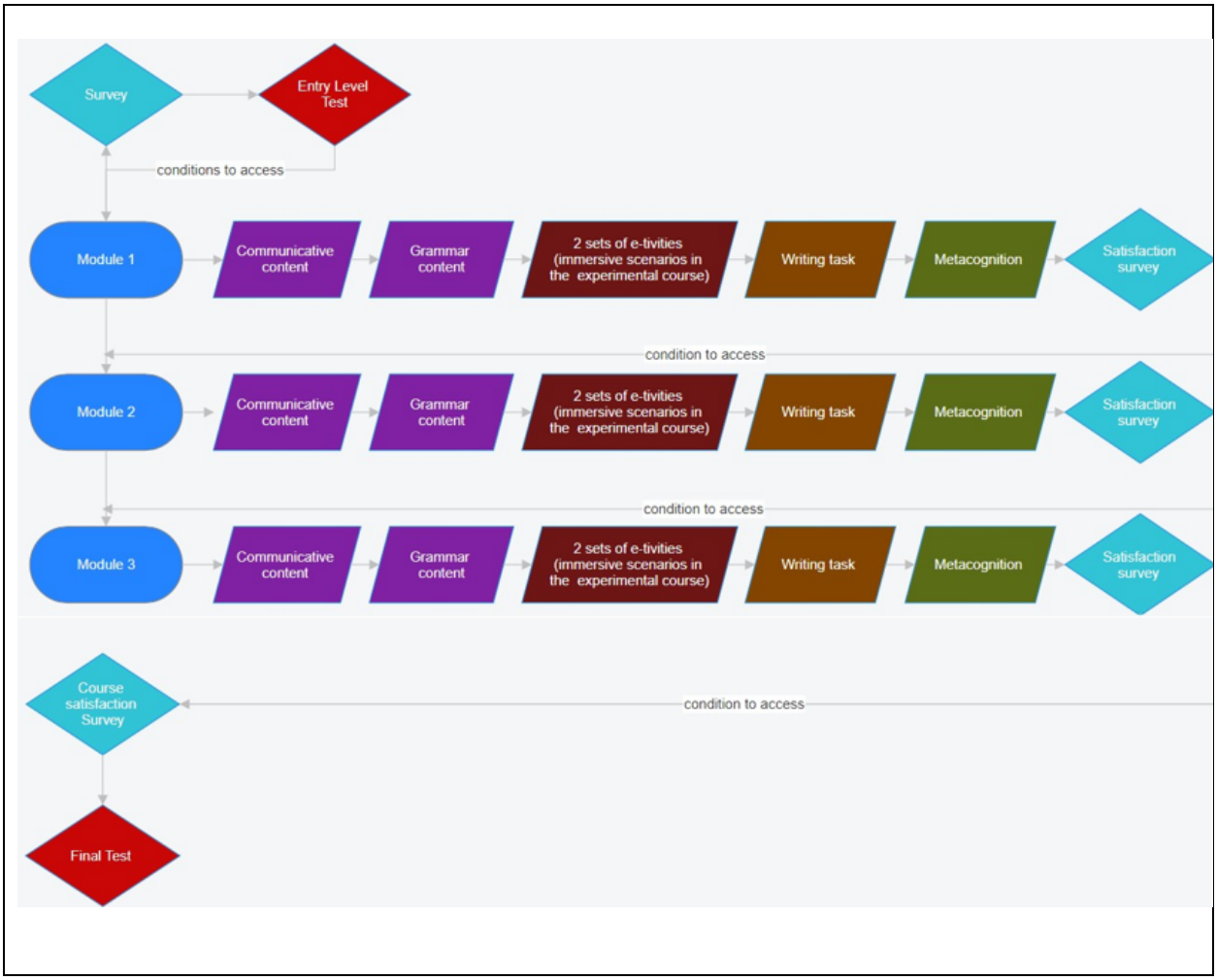
Appendix

Appendix A



Appendix B

Control Group

[a]	Minimum	Mean	Standard Deviation	Percentile 25	Median	Percentile 75	Maximum
clarity: 1 pt	,50	,75	,27	,50	,75	1,00	1,00
topic: 1 pt	1,00	1,00	,00	1,00	1,00	1,00	1,00
complex vocabulary: 1 pt	,25	,53	,21	,50	,50	,50	1,00
register: 1 pt	,50	,94	,18	1,00	1,00	1,00	1,00
linkers: 2 pts	,50	1,06	,42	1,00	1,00	1,00	2,00
grammar correctness: 2 pts	,50	1,38	,44	1,25	1,50	1,50	2,00
detailed descriptions of events/feelings/memories : 2 pts	1,00	1,31	,37	1,00	1,25	1,50	2,00
logic coherence : 2 pts	,50	1,31	,37	1,25	1,50	1,50	1,50
total / 12	6,75	8,28	1,40	7,25	8,00	9,00	11,00

a. Group = Controllo

Experimental Group

[a]	Minimum	Mean	Standard Deviation	Percentile 25	Median	Percentile 75	Maximum
clarity: 1 pt	,50	,95	,13	1,00	1,00	1,00	1,00
topic: 1 pt	,50	1,00	,10	1,00	1,00	1,00	1,00
complex vocabulary: 1 pt	,50	,79	,23	,50	,88	1,00	1,00
register: 1 pt	,75	,99	,06	1,00	1,00	1,00	1,00
linkers: 2 pts	,75	1,46	,33	1,50	1,50	1,50	2,00
grammar correctness: 2 pts	,75	1,45	,41	1,00	1,50	1,88	2,00
detailed descriptions of events/feelings/memories : 2 pts	1,00	1,78	,34	1,50	2,00	2,00	2,00
logic coherence : 2 pts	,00	1,73	,53	1,50	2,00	2,00	2,00
total / 12	8,50	10,11	,99	9,38	10,00	10,88	12,00

a. Group = Sperimentale

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of clarity: 1 pt is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,110[c]	Retain the null hypothesis.
2	The distribution of topic: 1 pt is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,862[c]	Retain the null hypothesis.
3	The distribution of complex vocabulary: 1 pt is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,025[c]	Reject the null hypothesis.
4	The distribution of register: 1 pt is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,746[c]	Retain the null hypothesis.
5	The distribution of linkers: 2 pts is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,016[c]	Reject the null hypothesis.
6	The distribution of grammar correctness: 2 pts is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,862[c]	Retain the null hypothesis.
7	The distribution of detailed descriptions of events/feelings/memories: 2 pts is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,011[c]	Reject the null hypothesis.
8	The distribution of logic coherence : 2 pts is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,010[c]	Reject the null hypothesis.
9	The distribution of total / 12 is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	,002[c]	Reject the null hypothesis.

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