ENHANCING COGNITIVE SKILLS THROUGH TECH-INTEGRATED CONTENT AND LANGUAGE INTEGRATED LEARNING

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ABSTRACT

The study explores the impact of technology-enhanced Content and Language Integrated Learning (CLIL) on the development of cognitive skills and language proficiency, as well as the perceptions of students and teachers regarding its effectiveness. Utilizing a mixed-methods experimental design, the study involved two groups: an experimental group that received CLIL instruction integrated with digital tools such as virtual reality (VR), gamified platforms and AI-driven language apps and a control group that experienced traditional CLIL instruction. Quantitative data from pre- and post-tests revealed significant improvements in the experimental group's cognitive skills— critical thinking, problem-solving, memory retention and metacognitive awareness—as well as enhanced language proficiency across reading, writing, speaking and listening domains. Qualitative insights from student and teacher interviews further indicated that technology-enhanced CLIL increased engagement and motivation, with students benefiting from personalized feedback and immersive learning experiences. Despite challenges related to technology access and familiarity, both students and teachers reported positive perceptions of the integration of digital tools in CLIL. The findings suggest that technology-enhanced CLIL is an effective approach for improving both cognitive and linguistic outcomes, offering a dynamic and engaging learning environment that aligns with the needs of 21st-century learners.

KEYWORDS: Content and Language Integrated Learning (CLIL), Cognitive Skills, Language Proficiency, Virtual Reality (VR) in Education & Gamified Learning Platforms.

1. INTRODUCTION

In today's fast-paced, technology-driven world, the educational landscape is evolving at an unprecedented rate. Content and Language Integrated Learning (CLIL), which promotes the simultaneous acquisition of content knowledge and language proficiency, has become an integral component of modern pedagogical strategies. Recent research highlights how CLIL not only supports language development but also contributes significantly to cognitive growth, offering learners a dual advantage of linguistic and cognitive development (Goris et al., 2022). In parallel, the rise of educational technology has revolutionized how content is delivered, processed and retained, leading to enhanced learning outcomes, particularly in the domain of cognitive skill development (Sung et al., 2022). This paper examines the synergy between CLIL and educational technology, focusing on how this integration can enhance cognitive skills, particularly critical thinking, problem-solving and metacognition, in learners.

CLIL is grounded in the cognitive theory of learning, which suggests that when learners process content in a non-native language, their brains engage in higher-order thinking and deeper cognitive processing (Coyle et al., 2010). This process is essential for cognitive development as it enhances executive functions such as working memory, attention control

and cognitive flexibility (Dalton-Puffer, 2011). Recent studies affirm that CLIL learners exhibit improved problem-solving abilities, better memory retention and heightened metacognitive awareness compared to those in traditional monolingual programs (Ruiz de Zarobe & Catalán, 2023). These cognitive benefits are attributed to the dual focus of CLIL, where students must simultaneously comprehend complex content and produce language, promoting active engagement and cognitive stimulation (Mehisto, 2018). The cognitive advantages of CLIL are also linked to the theory of cognitive load, which posits that learning in a second language increases the cognitive demands placed on learners (Sweller, 2011). However, when managed effectively, this increased load can stimulate cognitive growth, especially in areas like problem-solving and analytical thinking (Vandergrift, 2023). As learners navigate between content and language, they strengthen their ability to multitask, make connections across disciplines and apply critical thinking skills—all of which are essential for success in today's globalized knowledge economy (Lyster, 2017).

Educational technology has transformed the way students learn by providing tools that cater to diverse cognitive needs. Research shows that technology integration in classrooms can enhance students' cognitive skills, such as attention, memory and reasoning, by offering personalized, interactive and multimodal learning experiences (Sung et al., 2022). Digital platforms, such as learning management systems (LMS), gamified learning environments and immersive virtual reality (VR) tools, create rich, engaging environments that promote deep cognitive engagement (Clark & Mayer, 2016). By incorporating these technologies into CLIL, educators can offer students varied learning pathways, allowing for greater flexibility and cognitive development. Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) in educational tools provide even greater opportunities for cognitive skill development. For example, AI-driven language learning platforms, such as Duolingo and Babbel, use adaptive algorithms to personalize content delivery based on the learner's proficiency, providing tailored feedback and supporting metacognitive development (Hillmayr et al., 2020). Furthermore, AI-powered chatbots integrated into CLIL environments can simulate real-life conversations, prompting students to engage in problem-solving and critical thinking in real-time (Van den Branden, 2023).

The fusion of CLIL with educational technology offers a potent combination for cognitive skill enhancement. By integrating technology into the CLIL framework, educators can create immersive, interactive and personalized learning experiences that not only support language acquisition but also foster cognitive development. According to a recent study by Goris et al. (2022), students who participated in tech-integrated CLIL programs demonstrated significantly better outcomes in critical thinking, problem-solving and memory retention compared to those in traditional classrooms. These findings underscore the importance of multimodal learning, where technology serves as both a cognitive scaffold and a linguistic support. For instance, tools like augmented reality (AR) and virtual reality (VR) are gaining traction in educational settings for their ability to create immersive environments where students can explore complex concepts while practicing language skills. A 2023 study by Vandergrift demonstrated that CLIL learners using VR simulations in science subjects showed a marked improvement in both content mastery and cognitive abilities, particularly in spatial reasoning and conceptual understanding. These immersive experiences enable learners to engage with content in a multisensory manner, thus enhancing memory retention and cognitive flexibility (Ibáñez & Delgado-Kloos, 2018). Moreover, gamified learning environments have proven effective in boosting cognitive engagement in CLIL contexts. According to Hillmayr et al. (2020), gamification in educational settings encourages students to apply critical thinking and problem-solving strategies in real-time, promoting cognitive functions like attention regulation and perseverance. In the context of CLIL, these game-

based platforms can simulate real-world scenarios, requiring students to apply both language and content knowledge to solve problems, thus reinforcing cognitive skills (Van den Branden, 2023).

An important consideration in any educational setting is the management of cognitive load, particularly in CLIL environments where learners are required to process content in a second language. Recent research suggests that technology can play a critical role in managing cognitive load by offering scaffolding tools that break down complex information into more manageable segments (Paas, Renkl, & Sweller, 2022). For example, interactive video lessons in CLIL subjects allow learners to pause, review and reflect on challenging concepts, thereby promoting deeper cognitive processing and better retention (Clark & Mayer, 2016). Adaptive learning technologies, which adjust the difficulty of tasks based on the learner's performance, have also been shown to be effective in reducing cognitive overload (Sung et al., 2022). By providing personalized feedback and tailored instruction, these technologies support learners in navigating challenging content while simultaneously enhancing their cognitive abilities. In a 2023 study by Ruiz de Zarobe & Catalán, CLIL students using adaptive learning platforms outperformed their peers in both linguistic and cognitive tasks, demonstrating the effectiveness of technology in managing cognitive load while promoting deeper learning.

2. SIGNIFICANCE OF THE STUDY

The significance of this study lies in its exploration of how the integration of technology into Content and Language Integrated Learning (CLIL) can enhance cognitive skills such as critical thinking, problem-solving and metacognitive awareness, which are essential for 21st-century learning. By demonstrating the synergistic potential of tech-enhanced CLIL, the study contributes to improving educational outcomes, particularly in multilingual contexts where cognitive flexibility and language proficiency are key. This research is crucial for developing innovative pedagogical approaches that leverage digital tools to manage cognitive load, foster personalized learning and create inclusive, engaging environments. The study offers valuable insights for policymakers and educators globally, addressing the growing need for competency-based education that prepares students for lifelong learning and the demands of a knowledge-based economy. This study positions technology-integrated CLIL as a transformative approach to both linguistic and cognitive development, with broad implications for educational reform and global learning strategies.

3. METHODOLOGY OF THE STUDY

This study employed a mixed-methods approach, utilizing both quantitative and qualitative data collection techniques to investigate the impact of technology-integrated Content and Language Integrated Learning (CLIL) on cognitive skill development. The research design was experimental, involving two groups: an experimental group that received tech-enhanced CLIL instruction and a control group that followed traditional CLIL without advanced technological tools. The experimental group engaged with digital platforms such as interactive multimedia, virtual reality (VR), gamified learning environments and AI-powered language apps, which were integrated into their CLIL lessons, while the control group relied on conventional classroom methods. A total of 100 students from secondary schools in multilingual regions participated, with random assignment ensuring diversity in language proficiency, cognitive abilities and digital literacy. Quantitative data were collected through pre- and post-tests that assessed cognitive skills such as critical thinking, problem-solving, memory retention and metacognitive awareness, as well as language proficiency. Standardized tests like the Cognitive Skills Index (CSI) and Metacognitive Awareness Inventory (MAI) were used and statistical analyses, including paired t-tests and ANOVA,

were applied to compare the results between the two groups. Qualitative data were gathered through semi-structured interviews and focus group discussions with students and teachers from the experimental group, providing insights into their experiences with technology-enhanced learning and its impact on cognitive engagement. The technological tools used in the experimental group included interactive video lessons, VR simulations, gamified platforms and AI-based language learning apps, which were designed to reinforce both content and language acquisition while enhancing cognitive skills. The study's analysis employed thematic analysis for qualitative data, identifying recurring themes related to the cognitive benefits of technology in CLIL and statistical methods for quantitative data to measure cognitive improvements. To ensure validity and reliability, standardized assessments were used, random assignment reduced bias and triangulation of data collection methods strengthened the findings. Ethical considerations were addressed through informed consent, confidentiality and ensuring that the control group gained access to technological tools after the study concluded. This methodology provided a comprehensive approach to examining how the integration of technology in CLIL enhanced cognitive and linguistic outcomes, contributing valuable insights to educational practices and cognitive development research.

4. OBJECTIVES OF THE STUDY

1. To examine the impact of technology-integrated CLIL on the development of cognitive skills.

2. To evaluate the effectiveness of tech-enhanced CLIL in improving language proficiency.

3. To explore students' and teachers' perceptions of technology-enhanced CLIL.

5. FINDINGS OF THE STUDY

A. Impact of Technology-Integrated CLIL on the Development of Cognitive Skills (Based on Methodology)

The impact of technology-integrated Content and Language Integrated Learning (CLIL) on the development of cognitive skills was examined using a mixed-methods approach, combining both quantitative and qualitative data collection methods. The study utilized an experimental research design, where students were divided into two groups: an experimental group that received tech-enhanced CLIL instruction and a control group that followed traditional CLIL methods without the use of advanced digital tools. Through pre- and post-tests, semi-structured interviews and focus group discussions, the study aimed to assess how technology influences key cognitive skills, including critical thinking, problem-solving, memory retention and metacognition.

    a. **Critical Thinking and Problem-Solving-** To measure the impact of technology on critical thinking and problem-solving, pre- and post-tests were administered to both groups, focusing on tasks that required students to analyze and apply content knowledge in a second language. The experimental group, which utilized digital tools such as interactive multimedia and gamified platforms, demonstrated significant improvements in their ability to solve complex content-based problems compared to the control group. Statistical analysis using paired t-tests revealed that the experimental group had higher post-test scores, indicating enhanced critical thinking and problem-solving abilities. The immersive nature of virtual reality (VR) simulations used in the experimental group was particularly effective in promoting cognitive flexibility, as students had to navigate and solve real-world scenarios while applying language skills simultaneously. This finding aligns with research by

Vandergrift (2023), who noted that students in tech-enhanced CLIL environments developed greater cognitive flexibility and problem-solving abilities compared to those in traditional settings. Qualitative data from interviews and focus group discussions further supported these findings. Students in the experimental group reported that the use of technology made content more accessible and engaging, allowing them to think more critically about subject matter and solve problems more effectively. Teachers also observed that students in the experimental group were more engaged and better able to articulate their thought processes, linking this to the interactive, real-time feedback provided by the digital tools. In contrast, students in the control group relied more heavily on rote memorization and struggled with complex problem-solving tasks, as noted by their teachers.

b. **Memory Retention-** Memory retention was assessed through pre- and post-test results, where students were asked to recall key concepts from their CLIL lessons. In the experimental group, the integration of interactive multimedia resources and adaptive learning platforms showed a positive impact on students' ability to retain both language and content. Statistical analyses using ANOVA demonstrated that the experimental group significantly outperformed the control group in memory recall, with effect sizes indicating a notable difference in retention rates. This supports Mayer's (2009) cognitive theory of multimedia learning, which suggests that engaging multiple sensory channels (visual, auditory and kinesthetic) improves the retention of complex information. The use of AI-based adaptive learning platforms also contributed to improved memory retention in the experimental group. These platforms personalized learning by adjusting content difficulty based on each student's performance, ensuring that they practiced and reinforced challenging areas repeatedly. Students in the experimental group, during focus group discussions, reported that they found it easier to remember content when it was presented through interactive videos and simulations, as opposed to the traditional text-based materials used in the control group. Teachers in the experimental group also observed that students were able to recall specific details from lessons more accurately and quickly, attributing this to the repeated exposure and multisensory engagement provided by the digital tools.

c. **Metacognition and Self-Regulated Learning-** The study also examined the development of metacognitive skills and self-regulated learning by analyzing both quantitative test results and qualitative data from student reflections and teacher observations. The experimental group, which had access to learning management systems (LMS) and AI-driven platforms that tracked their progress and provided personalized feedback, demonstrated higher levels of metacognitive awareness than the control group. Pre- and post-tests measuring metacognitive awareness through the Metacognitive Awareness Inventory (MAI) revealed significant improvements in the experimental group's ability to plan, monitor and evaluate their learning strategies. Qualitative data from interviews further highlighted the advantages of technology in fostering self-regulated learning. Students in the experimental group reported feeling more in control of their learning, as the digital platforms allowed them to track their progress and reflect on areas where they needed improvement. Teachers observed that these students were more likely to set learning goals, monitor their understanding of content and adapt their study habits based on feedback provided by the digital tools. In contrast, students in the control group, who did not have access to these technological resources, were more dependent on teacher guidance and exhibited less initiative in managing their learning process.

d. **Cognitive Flexibility and Multitasking-** Cognitive flexibility, defined as the ability to switch between different tasks or concepts, was measured through tasks that required students to shift between language and content learning. In the experimental group, the use of gamified learning environments and VR simulations required students to simultaneously engage with subject-specific content and apply language skills, promoting cognitive flexibility and multitasking abilities. Statistical analysis of post-test results indicated that the experimental group showed greater improvement in tasks that required cognitive flexibility compared to the control group, whose learning activities were more static and language-focused. Interviews with students and teachers in the experimental group revealed that the dynamic nature of the technology-enhanced CLIL environment encouraged students to think on their feet and adapt quickly to changing scenarios. Students appreciated the challenge of switching between content and language tasks and teachers noted that these students demonstrated a greater ability to apply their knowledge across different contexts. In contrast, students in the control group, who experienced more traditional CLIL lessons, found it more difficult to manage the dual demands of language and content learning, as their cognitive flexibility was not as actively engaged.

B. EFFECTIVENESS OF TECH-ENHANCED CLIL IN IMPROVING LANGUAGE PROFICIENCY

The effectiveness of technology-enhanced Content and Language Integrated Learning (CLIL) in improving language proficiency was evaluated through a combination of quantitative assessments and qualitative observations. The study focused on how digital tools such as interactive multimedia, AI-driven language learning applications and gamified platforms impacted students' abilities in reading, writing, speaking and listening in a second language. The experimental group, which received tech-enhanced CLIL instruction, was compared to a control group that followed traditional CLIL methods without the use of advanced technology.

QUANTITATIVE ASSESSMENT OF LANGUAGE PROFICIENCY

Language proficiency in both the experimental and control groups was measured using standardized tests that assessed students' abilities in reading comprehension, writing accuracy, speaking fluency and listening comprehension. Pre- and post-tests were administered to evaluate improvements over the course of the study. In the experimental group, students used AI-based language learning apps, such as Duolingo and Babbel, which provided personalized lessons and immediate feedback on language performance. These apps adapted to each student's proficiency level, offering exercises tailored to their strengths and weaknesses, thereby creating a more individualized learning experience. In contrast, the control group relied on traditional text-based materials and teacher-led instruction. Statistical analysis of the post-test results showed that the experimental group outperformed the control group in all areas of language proficiency, particularly in speaking fluency and listening comprehension. The use of interactive multimedia and AI-driven feedback played a significant role in these improvements. Paired t-tests and ANOVA indicated that the experimental group experienced a greater increase in language proficiency, with effect sizes showing a significant practical difference between the two groups. These findings align with research by Goris et al. (2022), which suggests that personalized, tech-enhanced language learning environments lead to better outcomes in language acquisition.

SPEAKING AND LISTENING SKILLS

Speaking and listening skills, which are crucial in CLIL contexts, were significantly enhanced in the experimental group due to the integration of digital tools that encouraged active language use. The experimental group used VR-based simulations and AI-powered conversation bots, which provided immersive environments for practicing real-life dialogues. These tools allowed students to engage in natural language interactions and receive instant feedback on pronunciation, grammar and fluency. Post-test results revealed that students in the experimental group showed a marked improvement in their speaking fluency compared to the control group, who had fewer opportunities for interactive language practice. Qualitative data from focus group discussions further supported these findings. Students in the experimental group reported that the VR simulations helped them feel more confident in speaking the target language, as they were able to practice in a low-pressure, immersive setting. Teachers also noted that students in the experimental group were more willing to participate in oral activities and displayed improved pronunciation and conversational skills. Listening comprehension was similarly improved through the use of interactive audio materials, which provided a range of accents, speeds and contexts for language exposure. Students in the experimental group had more opportunities to engage with authentic listening materials, enhancing their ability to understand spoken language in real-world contexts.

WRITING AND READING SKILLS

The study also evaluated the impact of technology on writing and reading skills in the experimental group. Digital platforms with built-in grammar and vocabulary checks, such as Grammarly or AI-based writing assistants, provided immediate feedback on writing tasks, allowing students to correct mistakes and improve their language accuracy in real-time. The experimental group's post-test results in writing assessments showed a significant improvement in grammatical accuracy, vocabulary use and overall coherence compared to the control group. This was largely attributed to the instant feedback and scaffolding provided by the digital tools, which helped students refine their writing skills as they worked through their assignments. In terms of reading comprehension, the experimental group benefited from interactive eBooks and multimedia content that provided visual and auditory support for difficult passages. These tools allowed students to access definitions, translations and explanations instantly, making complex texts more accessible. As a result, the experimental group demonstrated better reading comprehension scores in the post-tests, with statistical analysis revealing a notable difference between their performance and that of the control group. Teachers in the experimental group also observed that students were more engaged with reading tasks and were able to independently navigate complex texts with the help of the digital resources provided.

QUALITATIVE INSIGHTS

Qualitative data from student interviews and teacher feedback indicated that the use of technology not only improved language proficiency but also enhanced students' motivation and engagement with language learning. Students in the experimental group expressed that the interactive and immersive nature of the technology made learning more enjoyable and accessible. They appreciated the personalized feedback provided by AI tools and found that the gamified elements of language learning encouraged them to practice more regularly. Teachers echoed these sentiments, noting that students in the experimental group were more autonomous in their language learning and required less prompting to engage with language activities. In contrast, students in the control group, who relied on more traditional methods, reported feeling less motivated to practice language outside of class. Teachers in the control

group also observed that their students were more reliant on direct instruction and less inclined to independently seek out language practice opportunities.

C. STUDENTS' AND TEACHERS' PERCEPTIONS OF TECHNOLOGY-ENHANCED CLIL

This study aimed to explore the perceptions of both students and teachers regarding the use of technology in Content and Language Integrated Learning (CLIL) environments, focusing on how digital tools impacted their learning and teaching experiences. Qualitative data were gathered through semi-structured interviews and focus group discussions with participants from the experimental group, who experienced tech-enhanced CLIL instruction. The insights from these discussions provided valuable information on the perceived benefits, challenges and overall effectiveness of integrating technology into CLIL.

i.   Students' Perceptions

Students' perceptions of technology-enhanced CLIL were overwhelmingly positive, with the majority of participants expressing that the use of digital tools significantly improved their learning experience. Many students highlighted the interactive and engaging nature of the technology, which made learning both the content and language more enjoyable and accessible. The use of virtual reality (VR), gamified platforms and interactive multimedia resources was particularly well-received, as students felt these tools helped them better understand complex subject matter while simultaneously improving their language skills. In focus group discussions, students reported that VR simulations, which immersed them in real-world scenarios, were especially effective for practicing their language skills in a practical context. These simulations not only provided a fun and immersive learning environment but also allowed students to practice speaking and listening in a second language without the fear of judgment or making mistakes. One student remarked, "It felt like I was really there, using the language in a real situation, which made me more confident in speaking." This sentiment was echoed by many students, who appreciated the low-pressure environment for practicing language. Students noted that AI-based language learning apps provided personalized feedback that was critical for improving their language proficiency. The instant corrections and tailored exercises helped them recognize their strengths and weaknesses, enabling them to focus on specific areas of improvement. Many students emphasized that this personalized approach motivated them to engage more with language learning outside of class, as they were able to track their progress and see tangible improvements. However, some students did express challenges with the technology, particularly those who were less familiar with digital tools. A few participants reported feeling overwhelmed by the complexity of certain platforms, particularly when trying to navigate between content learning and language practice. Despite this, the majority of students felt that the benefits of technology-enhanced CLIL outweighed the challenges, especially as they became more accustomed to using the digital tools.

ii.   Teachers' Perceptions

Teachers' perceptions of technology-enhanced CLIL were similarly positive, though they provided additional insights into the practical implications of integrating technology into the classroom. Many teachers appreciated the flexibility and adaptability that digital tools provided, allowing them to cater to diverse learning needs and styles. Teachers observed that students in the experimental group were more engaged and motivated to participate in class activities, particularly those involving interactive elements such as gamified learning and VR simulations. One teacher noted, "The students were much more active in class discussions and group work when we used the technology. They seemed more confident in using the

language and I think the instant feedback they received from the apps really helped." Teachers also found that the use of technology allowed for more differentiated instruction, as digital tools provided opportunities for students at different proficiency levels to learn at their own pace. AI-driven platforms, in particular, enabled teachers to assign individualized tasks that matched each student's language level, which was difficult to achieve in traditional CLIL settings. In terms of content delivery, teachers felt that technology-enhanced CLIL made complex subject matter more accessible for students. Interactive multimedia, such as videos and digital diagrams, provided visual and auditory support that helped students grasp difficult concepts while also improving their vocabulary and language comprehension. Teachers observed that students were better able to understand and retain content when it was presented through digital means, as opposed to traditional text-based materials. This multimodal approach to learning was seen as a key benefit of technology integration in CLIL. Despite these positive perceptions, teachers also highlighted some challenges with implementing technology-enhanced CLIL. A common concern was the time required to become familiar with the various digital tools and integrate them effectively into the curriculum. Several teachers mentioned that the initial learning curve for using the technology was steep and they required additional training to feel confident in implementing these tools. Furthermore, some teachers noted that not all students had equal access to technology at home, which created disparities in their ability to engage with the digital resources outside of the classroom. Another challenge noted by teachers was the potential for students to become overly reliant on technology for language learning. Some teachers expressed concerns that students might prioritize the feedback provided by AI tools over human interaction, which could limit their development of real-world communication skills. To address this, teachers emphasized the importance of balancing technology use with face-to-face interaction and group work in the classroom.

6. CONCLUSION OF THE STUDY

The study investigated the impact of technology-enhanced Content and Language Integrated Learning (CLIL) on cognitive skill development, language proficiency and the perceptions of students and teachers regarding its effectiveness. The results provide strong evidence that the integration of digital tools, such as interactive multimedia, virtual reality (VR), gamified platforms and AI-based language learning apps, significantly enhances both cognitive and linguistic outcomes in CLIL settings. The first objective, focused on cognitive skill development, revealed that students in tech-enhanced CLIL environments demonstrated notable improvements in critical thinking, problem-solving, memory retention and metacognitive awareness. These cognitive gains were attributed to the immersive, interactive and personalized learning experiences provided by the digital tools, which encouraged deeper engagement with both content and language. The second objective, examining language proficiency, showed that students receiving technology-enhanced instruction outperformed their peers in reading, writing, speaking and listening. The use of adaptive learning platforms and AI-powered language tools offered personalized feedback and practice opportunities that were instrumental in improving language fluency and comprehension, particularly in speaking and listening skills. The third objective explored the perceptions of students and teachers regarding the use of technology in CLIL. Both groups expressed positive views on the benefits of technology, particularly in terms of increased engagement, motivation and personalized learning. However, challenges related to the learning curve and access to technology were also noted, highlighting the need for balanced and equitable implementation of digital tools in educational settings. Overall, the study concludes that technology-enhanced CLIL is a highly effective approach for fostering cognitive and linguistic development in students. By leveraging the strengths of digital tools, educators can create dynamic, engaging

and inclusive learning environments that not only improve language proficiency but also promote essential cognitive skills. As educational technologies continue to evolve, integrating these tools into CLIL frameworks offers significant potential for enhancing both language learning and broader academic outcomes, making it a valuable strategy for 21st-century education.

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