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Challenges for being self-directed in content and language integrated learning with instructional videos

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Self-directed skills are crucial for video-based learning as learners often need to manage their pace, set goals, and engage with content independently. While much research focuses on the effectiveness of design and design principles in facilitating self-directed learning (SDL) in multimedia environments, boundary conditions arise due to the highly individualized and unique nature of each learning trajectory. This paper reports the findings of a case study involving five university students who speak English as an additional language (EAL). It explores the difficulties they faced while learning mathematics with instructional videos and the approaches they used to address these challenges in the context of Content and Language Integrated Learning (CLIL). Findings from video-stimulated recall (VSR) and semi-structured interviews reveal that language issues influenced and drove many decisions in their self-directed learning paths. Notably, the challenges of grasping academic language and terminology led participants to spend considerable time and effort on navigating video designs to aid language comprehension and on seeking extra resources to better understand the lectures. However, the lack of timely feedback and expert guidance posed further challenges for these EAL learners in identifying their knowledge gaps, thereby complicating the search for resources appropriate to their language and academic levels.

Keywords: CLIL, self-directed learning, video-based learning, educational technology, EAL, multimedia learning, sociocultural theory

Introduction

In recent years, the use of instructional videos has been significantly increased across Western universities (Wood et al., 2021). It is becoming a ubiquitous part of higher education which inherently influences all aspects of the student experience (Fyfield et al., 2019; Henderson et al., 2017). Video, a common method for delivering instructional content in online learning environments, is valued for its flexibility and ability to support self-paced learning (O'Callaghan et al., 2017). However, it can be a double-edged sword, as flexibility might lead to reduced engagement or mind wandering (Szpunar et al., 2014; Wammes & Smilek, 2017), creating problems for learners who may need additional support and real-time guidance (McKinney & Page, 2009; O'Callaghan et al., 2017).

Previous research has demonstrated that EAL learners face specific challenges when using instructional videos in content and language integrated learning (CLIL) environments within higher education, which can impact their learning outcomes (Yu et al., 2023). While much of the existing research has focused on the language comprehension issues encountered by English as an Additional Language (EAL) learners in CLIL settings and the supportive role of subtitles, transcripts, and other language tools, there remains a gap in understanding how these language challenges influence their self-directed learning (SDL) strategies during video learning, particularly the underlying reasons for these effects. Therefore, this study seeks to bridge this gap by examining the specific effects of language barriers on SDL strategies among EAL learners in video-based learning. Additionally, it explores how these processes might be influenced by video designs and learner's ontogenetic factors.

Background

Instructional scaffolding with videos and self-directed learning

ASCILITE 2024

Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

Recognizing the essential role of learner autonomy in video-based learning, extensive research has delved into self-directed learning in this context. According to Knowles (1975), SDL is defined as “a process in which individual take the initiative, with or without the help from others, in diagnosing their learning needs, formulating goals, identifying human and material resources, choosing and implementing appropriate learning strategies, and evaluating learning outcomes” (p.18). Although the concept of self-regulated learning (SRL) is sometimes conflated with self-directed learning (SDL) in cognitive studies due to their overlap in required skills within our cognitive architecture (Kester & van Merriënboer, 2021), it is important to distinguish between the two. SRL primarily refers to learner-driven activities or processes, while SDL encompasses both the learner's actions and the design features of the learning environment i.e., SDL can incorporate aspects of SRL, the reverse is not true (Loyens et al., 2008). SRL is often described as a desirable learner characteristic, whereas SDL addresses both the learner's initiative and how the environment supports that autonomy, making SDL more relevant to this study (Loyens et al., 2008).

In the search for effective video designs that support SDL, much research has focused on identifying key design principles in multimedia learning environments. Among the growing list of principles, four stand out as particularly relevant: the individualization principle, the pedagogical agent principle, the development portfolio principle, and the shared control principle (Kester & van Merriënboer, 2021). These principles can be applied to video design features such as playback controls that allow students to manage their learning pace, guided discovery through interfaces offering hints and feedback, and self-explanation prompts that encourage students to reflect on their learning goals (Fiorella, 2021; Fyfield et al., 2021). Moreover, integrating interactive learning activities, visual and auditory cues into the video could also help maintain learner's focus and engagement, thereby facilitating the processing of information (Fyfield et al., 2021; Jin et al., 2023).

While instructional scaffolding by video designs provide external support to learners, the active-processing assumption in Mayer's (2014) Cognitive Theory of Multimedia Learning (CTML) also implies the significant role of learner's agency in video learning. Building on Vygotsky's (1978) concept of the zone of proximal development (ZPD), previous research has investigated how learners can self-scaffold by managing their own learning process through identifying needs, setting goals, and finding resources using literacy sources such as textbooks, dictionaries, and worksheets, rather than relying solely on human interaction (Fani & Ghaemi, 2011). In conjunction with an earlier study conducted by Ohta (2005), which suggests that the ZPD can be internalized, allowing literate adults to manage their own ZPD through interactions with people and other sources in the learner's additional language (L2) rather than seeing it solely as interpersonal, these two concepts (self-scaffolding and internalized ZPD) may provide a new perspective in understanding the self-directed, video learning process in higher education, which often occurs without expert guidance and timely feedback.

Content and language integrated learning (CLIL)

The concept of CLIL emerged in Europe during the 1990s to describe various programs that use a second or additional language to teach specific content subjects within the curriculum (Eurydice, 2006). It is often referred to as a dual-focused approach in which both the content and language are acquired through language-supportive or language-sensitive teaching (Coyle et al., 2010). As an umbrella term, CLIL captures a variety of definitions and represents different methods including immersion, content-based instruction (CBI), content-based language teaching (CBLT), content and language integrated learning (CLIL), and English medium instruction (EMI) (Lin, 2016; Ruiz-Cecilia et al., 2023).

Research specifically targeting video learning within CLIL contexts remains limited compared to the body of research focuses on the video learning in language or mathematics education (Yu et al., 2023). While limited research has specifically examined EAL learners studying mathematics through videos, the studies that do exist often focus on either language issues or mathematics issues in isolation (Yu et al., 2023). Consequently, they may have overlooked crucial aspects of CLIL, where the intertwined nature of language and content and their

ASCILITE 2024

Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

dynamic interaction are fundamental (Yu et al., 2023). As a result, the effectiveness of certain video designs in facilitating mathematics learning through an additional language might be inaccurately assessed, potentially leading to the existence of boundary conditions (Yu et al., 2023).

The present study aims to bridge the gap in research by examining how the dynamic interaction between language and content learning influence the process of SDL with instructional videos for EAL learners, and hence how video designs mediate this interaction to support both language acquisition and content mastery in mathematics.

Conceptual framework

The current study draws on both Mayer's (2014) Cognitive Theory of Multimedia Learning (CTML) and Vygotsky's (1978) sociocultural theory, including related concepts such as the Zone of Proximal Development (ZPD) and agency (Edwards, 2005), to examine the self-directed learning in CLIL with videos.

The current study focuses on three key areas: self-directed learning, CLIL, and video learning. To examine how certain video designs influence EAL learners' processing of multimodal information, the study utilizes Mayer's CTML model, a framework commonly applied in multimedia learning research. Additionally, to understand how factors such as learners' language and cultural backgrounds may affect this process, Vygotsky's (1978) sociocultural theory, which is foundational to much of CLIL research, is also employed. Moreover, considering the critical role of learners' intrinsic motivation in self-directed learning, the concept of agency is explored to decipher how and why learners initiate certain learning strategies (Edwards, 2005). Finally, the concept of the zone of proximal development, which defines the difference between what learners can do without help and what they can achieve with guidance (Vygotsky, 1978), facilitates a discussion on how EAL learners identify their own knowledge gaps and seek additional learning resources to construct their own understandings in the absence of a traditionally defined more knowledgeable other (MKO).

Methods

Qualitative data collection

To capture the nuances of video learning as a real-life experience and its relevant context, a case study design was deemed suitable for addressing our "how" and "why" questions (Yin, 2018). Five participants, all native Chinese speakers, were recruited from undergraduate and postgraduate mathematics units at an Australian university. The participants, all pseudonyms, included Siyi, Ke, and Tong, who were postgraduate students, and Renjia and Linya, who were undergraduate students.

The data collection method comprised a 1.5-hour background interview and two video-stimulated recall (VSR) sessions for each participant. These VSR sessions were conducted following a 30-minute viewing of a lecture recording from their current mathematics courses, accessed via Echo360. Echo360 offers customizable subtitle settings such as size, colour, and position along with transcripts. In this instance, English was the only language option available for subtitles and transcripts. Immediately following the video-watching sessions, video-stimulated recalls (VSR) and semi-structured interviews were conducted in Chinese. This allowed participants to reflect on their learning experiences and discuss any challenges they encountered in a language they were comfortable with.

Ethics approval was provided by the institutional human research ethics committee before data collection.

Reflexive thematic analysis

Reflexive thematic analysis (TA), which conceptualizes researcher subjectivity as 'a source of knowledge' (Braun & Clarke, 2021, p. 334) was applied to interpret qualitative data. Drawing on the first author's

ASCILITE 2024

Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

experiences as an EAL learner and educator, the analysis aimed to develop a nuanced understanding of how social, cultural, cognitive, and affective factors might have influenced the learning of participants and the process under investigation.

The data analysis proceeded in multiple stages, beginning with an in-depth familiarization with the data through VSR recordings and participant interviews. Next, interview transcripts were coded to extract key concepts or patterns, which were then organized into themes. These themes were iteratively refined and contextualized, following Braun and Clarke's (2019) guidelines for reflexive engagement with the data.

Findings and Discussion

Language challenges as catalysts for self-directed strategies in video learning

Language challenges in CLIL settings emerged as a pivotal force in this study, pushing EAL students towards adopting self-directed learning strategies. Linya explained the possible cause of this phenomenon by referring to a common problem with the design of lecture recordings: 'University mathematics lecture videos...cannot possibly cater to the individual mastery of knowledge among each student... Sometimes, it may assume that students have already learned a particular concept and thus, detailed explanations are skipped'.

When encountering complex subject-specific terminology and academic language during video learning, participants adapted by manipulating video playback, such as pausing or rewinding. For instance, Siyi described why he decided to pause the video while he got confused 'I felt that if I continued [the video], it would only get worse. So, I decided to pause there, fully understand the current step first'. This adaptive approach is further highlighted by Siyi's iterative process of engaging with the material:

It's possible that the first time I watch [the video], I don't even understand the English. Then, maybe by the third time, I completely understand the English but not the concepts...And then maybe I start to get a general idea of what's being discussed, but still miss the key points, and I have to go back and forth over it.

This multiple-viewing strategy were also observed in Ke, who commented that 'the only times I need to pause are when the definitions themselves are complex, and I didn't understand them on the first go, then I might need to pause to make sense of it'.

Some researchers contend that language is the only medium through which we engage with mathematical concepts (Morgan et al., 2014). Vygotsky's notion of mediation enriches our understanding of CLIL by emphasizing that knowledge construction is fundamentally mediated through language (Vygotsky, 1962; Vygotsky & Cole, 1978). Thus, it is not surprising that in this study, language frequently emerges as the catalyst for adopting self-directed learning strategies for our EAL learners. The adaptive approaches of multiple viewings and pausing, as exemplified by Siyi and Ke, could also be explained by the limited capacity assumption of CTML which states that humans have finite cognitive resources available for processing information at any given time (Mayer, 2005, 2014). Therefore, by allowing EAL students to focus and refocus on complex content at their own pace, these viewing control techniques help to manage their cognitive loads, as well as direct their attention to critical information for the sense-making process. Given the dual focuses of CLIL on language and content which could potentially become unmanageable when the cognitive load is too high (Coyle et al., 2010), optimising the use of cognitive resources through enabling learner control functions of video could be particularly important in facilitating self-directed learning.

In addition to the use of learner control functions, Renjia also strategically managed her learning flow by using transcripts over subtitles for language comprehension to minimise the disruptions caused by video replay. Renjia explained her preference, 'I didn't want to jump back... I just paused it [the video], opened the transcript, and then looked at the previous lines to find the part where I didn't understand'. The drawbacks of

ASCILITE 2024

Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

subtitles have been extensively discussed through its transient effect which could result in superficial processing of information (Liao & Kruger, 2023; Liao et al., 2021). In contrast, transcripts provide a more detailed written account of all spoken content, allowing viewers to methodically review and revisit materials with less demands on controlling video playback to locate specific words manually. This approach allows Renjia to stay on track without losing context or momentum in the self-directed learning process. In fact, previous research has demonstrated that transcripts offer distinct advantages over second-language subtitles in promoting translanguaging strategies among EAL learners in CLIL contexts (Yu et al., 2023).

Ye offered an alternative perspective on the value of learner control functions and subtitles. She highlighted the psychological benefits of having control over video playback, stating, 'Videos can be paused, have subtitles, and can be slowed down or sped up. This flexibility makes me feel less anxious compared to in-person discussion'. Ye further explained that the anxiety was mainly due to language difficulties. This insight underscores how language barriers prompted EAL learners in video learning to adopt learner control features as a strategy in managing language-related stress.

The challenge with identifying knowledge gaps in CLIL with videos

Having observed how language barriers could prompt learners to adopt various self-directed strategies in video learning, participants also highlighted the deeper challenge of identifying conceptual knowledge gaps that are masked by language issues. Participant Siyi's experience is revealing; he recounted a particularly challenging episode: 'I sat through a whole class (video lecture) on learning about 'option'. 'Option', what's that supposed to mean? I was confused the entire time. It was only later, after some research, that I realized it was talking about the financial derivative jargon called option'. Despite turning on the English subtitles, the only available language option, the L2 subtitles did not help clarify the ambiguities he faced. This significant barrier in understanding had profound impacts on his learning experience, which he described as 'very distressed'. Similarly, Renjia also commented on a related issue, stating, 'Generally speaking, subtitles are only useful for everyday listening or for people who aren't very good at listening... the subject-specific terms you want to understand just aren't translated well'.

This brings to light a common issue in CLIL, identified by Cummins (2000), regarding the confusion between everyday and academic language. While learners may quickly acquire conversational language skills, developing the academic language necessary for fully grasping subject-specific content takes significantly longer (Cummins, 2000). To tackle the issue of ambiguity, most participants have employed translanguaging approaches to enhance their understanding. Siyi provided insightful evidence of this strategy, stating, 'In some cases, a mathematical concept may possess different names in English and Chinese. I often compare both names to determine which name aligns more closely with its intended meaning'. Similarly, Renjia often alternated between her L1 and L2. She preferred to remember the names of terms and concepts in English because that was what she would use while studying in Australia, explaining this as the need to 'adapt to the culture.' However, for accurate conceptual understanding, she still wanted to see the explanation of concepts in her mother tongue.

In another paper by the authors (Yu et al., 2023), its discussion highlights how the translanguaging approaches enable EAL learners to tap into the knowledge repositories in both L1 and L2, thereby accessing more contextual information to mediate the mathematical understanding of new concepts. While multiple participants suggested that the inclusion of bilingual subtitles might potentially support their translanguaging strategies during this self-directed process, Renjia provided an interesting perspective. She pointed out that the terms she learned directly in English effectively became her first language. This observation implies the fluidity of the definition of 'first language' in CLIL, highlighting important implications for studying the roles and effectiveness of 'L1', 'L2', and bilingual subtitles.

Behind the issue with language comprehension, Siyi's case of misunderstanding the term 'option' also reveals a more profound issue: The frequent misdiagnosis of content comprehension problems as language issues

ASCILITE 2024

Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

leads to valuable time being spent seeking language assistance when what is required is conceptual clarification. This masking effect complicates learners' ability to diagnose and pinpoint their own knowledge gaps, thus impairing their efficiency in self-directing towards the appropriate resources. Renjia echoed this concern, stating, 'Sometimes I'm afraid that I won't understand it [the knowledge], or that I have misunderstood the meaning, which could lead to mistakes in [choosing] my subsequent tasks'. Self-assessment has been shown to be a crucial component of self-directed learning (Loyens et al., 2008), and hence, accurately identifying and addressing one's own knowledge gaps is essential for effective learning. This appears to be especially important for EAL learners in CLIL settings, who need to differentiate between language and subject-specific knowledge gaps in the absence of immediate feedback or expert guidance. Therefore, instructional designs and integrated activities that support this differentiation become crucial to enhance the effectiveness of self-directed learning for these learners.

Navigating learning resources and video designs

To resolve the challenges of simultaneously acquiring both language and content in CLIL, various approaches have been adopted by the participants to separate the learning processes for language and subject matter. This included engaging in practical exercises to apply concepts, using visual aids for better comprehension, and relying on first language (L1) materials to establish a strong foundational understanding before transitioning to the target language. For instance, Renjia, who identified herself as a 'visual learner', commented, 'Even if the teacher doesn't explain much, I can still understand a lot from looking at the pictures'. She gave an example, 'When the teacher explained a concept using a number line, it was very easy for me to understand because this is a commonly used tool in mathematics'. Similarly, Ke highlighted the efficiency and clarity provided by visual aids over text while learning mathematics with videos, emphasizing their roles in making complex concepts more intuitive.

While their approaches to self-directed learning tasks could be driven by language issues, it was found that the choices of learning resources or activities to supplement the video lecture were also closely linked to their beliefs and attitudes towards mathematics learning. For instance, both Ke and Siyi expressed a strong belief in the universal language of mathematics. Ke noted that 'the language of mathematics is actually just symbols; it is universally understood around the world'. Siyi echoed this sentiment, stating, 'Mathematics itself is also a language' and emphasizing that 'you can write a proof without using any Chinese or English, and everyone can understand it'. This belief and attitude were reflected in the significant amounts of time they both spent during the observed video watching sessions engaging in exercises and reviewing example questions. Ke emphasized the importance of practical application, believing that learning mathematics must involve examples, whether it's solving problems or seeing how others use mathematics in real-life situations. This focus underscores their conviction that mathematics can transcend language barriers through its symbolic nature, thereby prompting them to direct their attention to parts of the video lectures that focus on examples and to invest their time in the practical aspects of mathematics. Renjia also pointed out the need to integrate more exercise questions into the mathematics lecture video, stating, 'I think I need more problems to practice'.

Interestingly, there is a notable contradiction in the learning experiences of participants observed in this study. While students believe that mathematics is a universal language, their experiences suggest otherwise—they struggled to varying degrees when learning mathematics in a non-native language. Vygotsky's notions of genetic method and mediation suggest that learners' beliefs and values shape their learning approaches and behaviours. In this case, misconceptions about mathematics as a purely symbolic system may have led learners to underestimate the importance of understanding certain terms. As a result, they might choose to ignore or guess the meaning of unfamiliar terms, assuming these terms are mere symbols rather than concepts. This behaviour could be explained by the principle of cognitive economy, which states that learners may avoid further cognitive processing if they perceive the benefits to be outweighed by the cognitive effort required (Schnotz, 2021). The conflict between learners' beliefs and their actual experiences has profound

ASCILITE 2024

Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

implications for their approach to self-directed learning, suggesting that instructional video designs should address these misconceptions and the impact of language on learning.

Conclusion

This study examined the challenges and strategies of self-directed learning among EAL students in CLIL settings with a focus on instructional videos for mathematics. While the findings are not intended for broad generalization due to the small sample size, they offer important insights into how and why language barriers influence learners' self-directed learning paths. The findings reveal that learners may be prompted to adopt translanguaging approaches and heavily use video control features such as pausing, rewinding, and using subtitles in order to get through the language barriers for knowledge construction. Additionally, their beliefs and attitudes towards mathematics, such as viewing it as a universal language, shaped their choices and engagement with learning resources and activities. In contrast to their common belief in the symbolic nature and universality of mathematics, participants faced considerable challenges in understanding mathematical content presented in a non-native language. This highlights a contradiction between their perception of mathematics and practical experiences which may prevent them from accurately identifying their learning needs.

These findings have important implications not only for the instructional design of videos in CLIL contexts but also for CLIL that occurs in video learning environments. While much research has explored effective video designs to support language and mathematics learning, these two subject areas are often studied separately. A major concern is the cognitive impact on EAL learners due to the intertwined nature of language and content in CLIL, which could influence the perceived effectiveness of certain video designs and integrated learning activities. Fully understanding what works and what does not in video learning for EAL learners in CLIL contexts is crucial, particularly since this learning process frequently occurs independently, without immediate support or expert guidance from a traditionally defined more knowledgeable other.

While the concept of self-scaffolding has appeared in previous studies, providing an alternative perspective on conceptualising the self-directed learning process, a key question arising from the present study is whether EAL learners can successfully self-scaffold without the presence of a more knowledgeable other, especially when they face such challenges and difficulties in identifying their knowledge gaps and needs during video learning. If they can, it is important to identify the enabling and inhibitory factors in this process and hence the role of video designs in mediating those factors. Future research could also explore the influential factors and aspects with a larger sample EAL students encompassing diverse cultural and linguistic backgrounds, with varying levels of English proficiency and mathematics skills to understand how these spectrums may affect the effectiveness of video designs.

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ASCILITE 2024

Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

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ASCILITE 2024

Navigating the Terrain:

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