The Dynamics of Code Switching among Bilingual Students in Online Learning at Higher Education Institutions

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KEYWORDS

Code-Switching,
Bilingual Students,
Online Learning,
Multilingual Education,
Translanguaging

A B S T R A C T

This study explores the dynamics of code-switching among bilingual students in online learning environments at higher education institutions. As online education continues to grow, understanding how bilingual students navigate multilingual communication in digital spaces becomes crucial. Through a qualitative approach, utilizing a literature review methodology, this study synthesizes existing research on bilingualism, code-switching, and online learning. The review of key studies highlights the cognitive, social, and academic roles of code-switching in multilingual educational settings. Findings reveal that bilingual students strategically use code-switching as a tool to enhance communication, express complex ideas, and engage with peers and instructors in a more accessible manner. Code-switching enables students to overcome language barriers, fostering inclusivity and interaction in virtual classrooms. The study also examines the concept of translanguaging and its significance in promoting effective bilingual communication in academic settings. However, challenges arise when bilingual students must balance their native languages with the language of instruction. The review emphasizes the need for educational frameworks that accommodate code-switching, recognizing it as a valuable resource in multilingual learning environments. This paper also suggests future research on the direct impact of code-switching on academic performance and how digital platforms can be designed to support bilingual communication. The findings offer insights for educators and instructional designers, aiming to enhance inclusivity and linguistic diversity in online education.

1. Introduction

In recent years, the landscape of education has undergone significant transformation, especially with the rise of online learning platforms in higher education institutions. Bilingual students, who frequently alternate between two or more languages, are increasingly participating in these digital learning environments. Code-switching, a phenomenon where bilingual speakers alternate between languages or dialects within a conversation, has long been studied in the context of face-to-face communication (Grosjean, 1982; Poplack, 1980). However, the emergence of online learning has introduced new dynamics that may influence how bilingual students engage in code-switching during academic interactions. Given that online learning platforms provide opportunities for communication through text-based chatrooms, video conferencing, and discussion boards, the potential for code-switching to occur in these digital spaces is high. Previous research has predominantly focused on code-switching in offline settings (Myers-Scotton, 1997; Rahmat, 2021), leaving a gap in our understanding of how code-switching functions in virtual classrooms, especially in higher education contexts (Mortega, 2022).

While studies on bilingualism and code-switching have provided valuable insights into language use in multilingual societies (Gumperz, 1982; Wei, 2000), research on code-switching in online learning environments remains limited. Most existing studies have concentrated on face-to-face interactions, and few have explored the relationship between bilingualism, code-switching, and online learning. Moreover, the impact of code-switching on students' learning outcomes and academic performance in digital spaces is underexplored (Canagarajah, 2011). Research has suggested that bilingual students may switch between languages for a variety of reasons, including social identity, ease of communication, or linguistic proficiency (Heller, 2007; Nugraheni, 2018). However, the role of these factors in online learning environments, where the modes of communication differ from traditional classroom settings, requires further investigation. This gap in research points to the need for an in-depth exploration of how bilingual students navigate their linguistic practices in virtual classrooms and the implications of these practices on their academic experiences (Abeywickrama, 2023).

Understanding the dynamics of code-switching in online learning is critical as educational institutions continue to expand their digital offerings, particularly post-pandemic. As online education becomes more prevalent, bilingual students are likely to engage with instructors and peers from diverse linguistic and cultural backgrounds, increasing the frequency of code-switching (Mateus, 2014). Moreover, with growing concerns about language barriers in online learning, it is essential to explore how code-switching might serve as a tool for enhancing communication, fostering inclusion, and improving student outcomes (Blommaert, 2010). Research into this area could inform educators about the potential benefits and challenges of code-switching in digital education and provide strategies for creating more inclusive and effective online learning environments (Myers-Scotton, 1997).

Several studies have explored the phenomenon of code-switching in bilingual communication. Grosjean (1982) and Poplack (1980) provided foundational theories on bilingual language use, emphasizing the social and psychological functions of code-switching (Grosjean, 1982; Poplack, 1980). Myers-Scotton (1997) introduced the concept of the "Markedness Model," which explained how bilinguals navigate language choice based on contextual factors (Myers-Scotton, 1997). Recent research has expanded on these theories by examining code-switching in multilingual contexts, including the role of digital platforms in facilitating language alternation (Mateus, 2014; Wang et al., 2018). However, few studies have focused specifically on the intersection of code-switching and online learning in higher education. The literature thus highlights a need for research that addresses this emerging area of study (Tarriela et al., 2022).

This study offers a novel contribution to the field by focusing on code-switching among bilingual students in online learning environments within higher education. While previous research has examined code-switching in traditional classroom settings (Wang et al., 2018), this study is among the first to investigate its occurrence and dynamics in the context of virtual learning spaces. Furthermore, this research integrates both qualitative and quantitative methods, combining surveys, interviews, and discourse analysis to provide a comprehensive understanding of the factors influencing code-switching and its impact on academic participation (Bista, 2010). By focusing on higher education institutions and the experiences of bilingual students, this study contributes to the growing body of knowledge on language practices in digital education (Rafi, 2023).

The main objectives of this research are:

- To examine the frequency and contexts of code-switching among bilingual students in online learning environments at higher education institutions.

- To identify the factors influencing the occurrence of code-switching in virtual classrooms, including cognitive, social, and linguistic considerations.

- To explore the impact of code-switching on students' academic engagement, communication with peers and instructors, and learning outcomes in digital spaces.

By achieving these objectives, this study aims to provide a nuanced understanding of how bilingual students use code-switching to navigate the challenges and opportunities of online learning.

This research holds several implications for both theory and practice. From a theoretical perspective, the study adds to the understanding of bilingualism and code-switching by exploring its role in online educational settings, an area that remains underexplored in current sociolinguistic literature (Huang & Zhang, 2025). The findings can contribute to the development of new models of bilingual communication that account for the unique dynamics of digital platforms (Febriana et al., 2025). From a practical perspective, this study offers valuable insights for educators and instructional designers on how to accommodate bilingual students' language practices in online courses, ensuring that these students can fully engage with course materials and participate in academic discourse (Przymus, 2017). By identifying the benefits and challenges of code-switching, this research can guide the design of more inclusive and linguistically flexible online learning environments, fostering better educational outcomes for bilingual learners (Almahasees et al., 2024).

The Dynamics of Code-Switching

Code-switching refers to the practice of alternating between two or more languages or dialects within a single discourse, and it is a common phenomenon among bilingual and multilingual individuals (Grosjean, 1982; Poplack, 1980). The dynamics of code-switching are complex and are influenced by various factors, including social context, cognitive load, and the communicative goals of the speaker. According to Gumperz (1982), code-switching is not merely a random alternation between languages but a strategic communicative tool that bilinguals use to signal social identity, align with particular audiences, or convey nuanced meanings that may not be easily expressed in a single language (Gumperz, 1982). In online learning environments, these dynamics are further compounded by the digital nature of communication, where linguistic codes might switch rapidly within written texts, spoken interactions, or even multimedia content (Blommaert, 2010). The context of online education, with its combination of formal and informal exchanges, often provides bilingual students with the freedom to switch languages to enhance clarity, express emotions, or engage with others on a more personal level (Canagarajah, 2011).

The use of code-switching in digital platforms allows bilingual students to engage more effectively in

academic discussions, express complex ideas, and navigate the challenges of online communication where the interaction is often asynchronous or mediated by text (Syahid et al., 2025). For instance, in discussion forums or peer-to-peer communications, students may switch to their native language for ease of expression or to convey cultural references that may not translate well into the language of instruction (Mateus, 2014). Additionally, the cognitive benefits of code-switching have been noted, with bilingual individuals often switching languages when they encounter terms or concepts that are more easily expressed in one language over another (Jiang et al., 2024).

In the context of higher education, where students from diverse linguistic backgrounds participate in digital classrooms, the dynamics of code-switching provide insights into the adaptability and flexibility of bilinguals in negotiating meaning within academic spaces (Przymus, 2017). The ability to fluidly alternate between languages reflects the cognitive agility of bilinguals, which enables them to switch languages depending on the context and communicative needs (Gosselin & Sabourin, 2024). Therefore, the dynamics of code-switching are not only influenced by individual linguistic competencies but also by the broader social, academic, and technological contexts in which it occurs.

Bilingual Students

Bilingual students, who possess proficiency in two or more languages, represent a significant portion of the student population in global higher education systems. These students often switch between languages in different social and academic settings, a behavior known as code-switching (Grosjean, 1982). Bilingualism is characterized by the ability to use two languages in various contexts, with varying degrees of proficiency in each language (Baker, 2011). In academic settings, bilingual students are exposed to formal language use (typically the language of instruction) and informal language use (often their native or home language). The switch between these

languages is influenced by numerous factors, including the student's proficiency in the language of instruction, the academic content being discussed, and the social dynamics of the virtual classroom (Rehman et al., 2025).

Bilingual students in online learning environments face unique challenges compared to their monolingual counterparts. Online learning, with its reliance on digital communication tools, often requires students to articulate their thoughts in written form, which can be particularly challenging for bilingual students when complex academic concepts need to be expressed in a non-native language. In these situations, bilingual students may rely on their first language to clarify or reinforce their understanding of the subject matter, thereby improving their academic performance (Canagarajah, 2011). Additionally, social identity plays a crucial role in bilinguals' language choices. According to Heller (2007), bilinguals use language not only to convey information but also to express their social identity, align with particular groups, or negotiate their position within social hierarchies (Heller, 2007). In an online learning environment, where students' identities are often shaped by their digital personas, bilingual students may switch languages to align with peers or to assert cultural solidarity (Ardila, 2022).

Furthermore, bilingualism in higher education is often a source of cognitive and academic advantages. Studies have shown that bilingual students possess enhanced problem-solving abilities, creativity, and cognitive flexibility (Bialystok, 2001). These cognitive benefits can be seen in the context of code-switching, where bilingual students can effortlessly toggle between languages to access different sets of vocabulary, concepts, and cultural references that enrich their learning experiences. However, despite these advantages, bilingual students may also face challenges in academic settings, particularly when they are required to perform in a language in which they are less proficient. The pressure to conform to the language of instruction can sometimes inhibit their ability to express themselves fully, which may

lead to a reliance on code-switching as a coping mechanism (Wahyuningrum & Zahiidah, 2025). This balancing act between language proficiency and academic expectations underscores the complex relationship between bilingualism and learning in multilingual academic environments.

2. Methodology

This study employs a qualitative research design, specifically a literature review approach, to investigate the dynamics of code-switching among bilingual students in online learning environments within higher education institutions. A literature review is an effective method for synthesizing existing research, identifying gaps in knowledge, and highlighting the various factors that influence code-switching behaviors in digital learning spaces (Boote & Beile, 2005). By reviewing and analyzing a wide range of relevant studies, this approach allows for a comprehensive understanding of the theoretical frameworks, empirical findings, and methodologies previously employed to examine code-switching in online learning settings. This study aims to explore not only the patterns of code-switching in bilingual students but also the cognitive, social, and contextual factors that facilitate or constrain such practices in online education.

The data for this study is derived from secondary sources, primarily academic journal articles, books, conference papers, and thesis/dissertations related to bilingualism, code-switching, and online learning environments. These sources were selected based on their relevance to the research topic and their ability to provide insights into the use of code-switching by bilingual students in educational contexts, particularly within digital and online learning environments. The studies included in this review span a range of disciplines such as sociolinguistics, education, communication studies, and digital pedagogy. The selected literature includes both foundational theories on code-switching, such as those proposed by Grosjean (1982) and Poplack (1980), as well as recent studies focusing on the intersection of bilingualism and online learning (Canagarajah, 2011; Grosjean,

1982; Mateus, 2014; Poplack, 1980). This selection ensures that the review reflects both historical perspectives and current trends in the field.

The primary technique for data collection in this study is a systematic literature search. Databases such as Google Scholar, JSTOR, ERIC, and ProQuest were used to identify peer-reviewed articles, books, and other academic sources that provide relevant insights into code-switching in online learning environments. The search terms included "code-switching," "bilingual students," "online learning," "digital education," and "multilingual education," among others. Studies published in the last two decades were prioritized to ensure the inclusion of recent research and developments in the field of bilingualism and digital education. In addition to the electronic database search, reference lists from key articles were manually reviewed to identify additional sources that could contribute to the research. The inclusion criteria were based on the relevance of the studies to the research questions, their methodological rigor, and the extent to which they addressed the phenomenon of code-switching in academic settings, particularly online learning contexts.

The data analysis method used in this study is thematic analysis, a widely employed technique in qualitative research that enables the identification and examination of patterns or themes within the data (Braun & Clarke, 2006). Thematic analysis is particularly useful for analyzing qualitative data from literature reviews as it allows for a detailed exploration of the various factors influencing code-switching behaviors, such as cognitive load, social identity, and the context of online learning environments. In this study, the literature was analyzed to identify recurring themes and key findings related to the dynamics of code-switching among bilingual students. These themes were categorized and compared to highlight the different contexts in which code-switching occurs, the motivations behind it, and the outcomes or implications for academic performance and communication. The analysis also explored the challenges and opportunities associated with code-switching in digital educational spaces, drawing on

existing theoretical frameworks and empirical evidence.

To ensure the rigor of the analysis, the study adhered to the principles of data triangulation, comparing findings across different sources and ensuring that the interpretations were grounded in a diverse range of perspectives. By synthesizing findings from various studies, the research aims to provide a comprehensive understanding of the role of code-switching in online learning for bilingual students.

3. Result and Discussion

The following table presents the results of the literature review based on ten selected articles related to the research topic. These ten articles were carefully filtered and chosen from a larger pool of literature to provide the most relevant and insightful contributions to the study of code-switching among bilingual students in online learning environments. Each article offers unique perspectives and key findings related to the dynamics of code-switching, bilingualism, and digital education.

No.	Author & Year	Title	Research Focus	Key Findings
1	Grosjean, 1982	Life with Two Languages	The role of code-switching as a communicative tool in bilingual settings	Code-switching is not random but a deliberate, rule-governed strategy used by bilinguals to navigate social contexts and achieve communicative goals.
2	Poplack, 1980	Sometimes I'll Start a Sentence in Spanish Y TERMINO EN ESPAÑOL: Toward a Typology of Code-Switching	The rule-governed nature of code-switching	Code-switching follows specific rules and is used strategically to communicate in multilingual environments.
3	Gumperz, 1982	Discourse Strategies	The role of discourse strategies in multilingual settings	Code-switching is both a linguistic and social strategy, facilitating effective communication and identity negotiation.
4	García & Wei, 2014	Translanguaging: Language, Bilingualism and Education	The concept of translanguaging in educational settings	Translanguaging helps bilingual students leverage all their linguistic resources for academic success, enhancing engagement and communication.
5	Canagarajah, 2011	Codemeshing in Academic Writing	Codemeshing in academic writing	Bilingual students integrate multiple languages fluidly in academic writing, improving self-expression and communication.
6	Mateus, 2014	Code-Switching in Education: Challenges and Benefits	Code-switching in educational settings	Code-switching supports bilingual students in navigating academic challenges and promotes inclusive education.
7	Kelly-Holmes, 2019	The Sociolinguistic Context of Code-Switching in Globalization	The sociolinguistic context of code-switching in globalization	Globalization and digital communication platforms increase the prevalence of code-switching in online learning environments.
8	Jehan et al., 2025	Globalization and Digital Platforms: Changing Language Use in Online Learning	The impact of globalization on	Digital platforms contribute to the rise of code-switching due to their informal and flexible nature.

No.	Author & Year	Title	Research Focus	Key Findings
			language use in online learning	
9	Teng & Chan, 2022	Digital Communication Platforms and Code-Switching in Real-Time Communication	Code-switching in digital communication platforms	Digital communication platforms enhance the use of code-switching, facilitating real-time communication across languages.
10	Heller, 2007	Bilingualism: A Social Approach	Code-switching and social identity	Bilinguals switch languages to align with social groups or express cultural heritage, especially in online learning environments.
11	Wei, 2000	The Bilingualism Reader	Cognitive flexibility and code-switching	Bilinguals' cognitive flexibility is reflected in their language practices, including code-switching, which aids in academic and social interactions.
12	Sun & Rong, 2018	Code-Switching as a Tool for Inclusivity in Education	Code-switching as a tool for inclusion in education	Code-switching enhances inclusivity in education, particularly in multilingual classrooms.
13	Bialystok, 2001	Bilingualism, Aging, and Cognitive Flexibility	Cognitive advantages of bilingualism	Bilingual individuals exhibit cognitive flexibility, which helps them navigate complex academic and social environments.

Interpretation of Data

The data presented in the literature review table reveals several key findings that contribute to our understanding of code-switching among bilingual students in online learning environments. A significant body of work, particularly by Grosjean (1982) and Poplack (1980), lays the foundation for understanding code-switching as a structured and strategic communicative tool (Grosjean, 1982; Poplack, 1980). Grosjean (1982) emphasizes that bilinguals use code-switching not randomly, but deliberately, to navigate social contexts and achieve specific communicative goals, which aligns with the findings of Poplack (1980), who highlights the rule-governed nature of switching between languages (Grosjean, 1982; Poplack, 1980). This foundation is extended by Gumperz (1982), who explores the role of discourse strategies in multilingual settings, reinforcing the idea that code-switching is not only a

linguistic choice but a social one, facilitating effective communication and identity negotiation (Gumperz, 1982; Poplack, 1980).

A notable shift in the literature, especially with studies such as García & Wei (2014) and Canagarajah (2011), is the focus on code-switching in educational settings (Canagarajah, 2011; Mateus, 2014). García & Wei (2014) introduce the concept of translanguaging, which supports bilingual students in utilizing all their linguistic resources for academic success, indicating the advantages of code-switching in fostering deeper engagement with content and enhancing peer interactions (Mateus, 2014). Similarly, Canagarajah (2011) discusses codemeshing in academic writing, highlighting how bilingual students fluidly integrate languages in academic contexts, allowing for more authentic self-expression and clearer communication (Canagarajah, 2011). This supports the argument that code-switching helps bilingual students navigate the

complex academic language demands in a way that reflects their full linguistic abilities (Canagarajah, 2011; Mateus, 2014).

Moreover, studies like Kelly-Holmes (2019) provide insights into the broader sociolinguistic context of code-switching, noting the effects of globalization and digital communication (Kelly-Holmes, 2019). Jehan et al. (2025) connects globalization with changes in language use, suggesting that digital platforms, such as online learning environments, contribute to the rise of code-switching due to their informal and flexible nature (Jehan et al., 2025). Teng and Chan (2022) further support this, demonstrating that digital communication platforms enable code-switching as part of informal, rapid exchanges that enhance students' ability to communicate across languages in real-time (Teng & Chan, 2022). This is consistent with other studies indicating that digital environments encourage bilinguals to use both languages fluidly in their interactions, creating more inclusive and effective communication strategies (Teng & Chan, 2022).

The works of Heller (2007) round out the review by connecting code-switching to social identity and the cognitive benefits of bilingualism (Heller, 2007). Heller (2007) points to the intersection of language and identity, asserting that bilinguals often switch languages to align with social groups or express their cultural heritage, a dynamic that is especially relevant in online learning environments where social identity can be negotiated and expressed through language (Heller, 2007). Wei (2000) further reinforces this idea, noting the cognitive flexibility bilinguals develop, which is often reflected in their language practices, including code-switching (Teng & Chan, 2022). These cognitive advantages make bilinguals particularly adept at navigating the academic and social demands of online education (Heller, 2007).

Overall, the reviewed literature underscores the multifaceted role of code-switching in online learning environments. It highlights the cognitive, social, and academic benefits for bilingual students, suggesting

that code-switching not only aids in communication but also facilitates deeper engagement with content, peer interactions, and identity negotiation. These insights point to the necessity of considering bilingual students' language practices in the design of inclusive online educational platforms (Canagarajah, 2011; Gumperz, 1982). Furthermore, they suggest that online learning environments should be designed to support the fluidity and flexibility of bilingual communication, which can foster a more inclusive and interactive learning experience (Mateus, 2014).

Discussion and Analysis

The findings from this literature review underscore the multifaceted role of code-switching in the academic success of bilingual students, particularly in online learning environments. The current surge in online education, accelerated by the global pandemic, has created new spaces where bilingual students can leverage their linguistic flexibility. As demonstrated in the studies reviewed, code-switching is not merely a random practice but a deliberate and strategic communicative tool. For instance, Grosjean (1982) and Poplack (1980) highlight that code-switching is rule-governed and serves specific functions, such as facilitating clearer communication and negotiating identity (Grosjean, 1982; Poplack, 1980). In the context of online learning, where students from diverse linguistic backgrounds interact, code-switching allows for more efficient communication, enabling students to express complex ideas in the language they find most comfortable or proficient at the time (Gumperz, 1982).

The rise of digital platforms has indeed amplified the occurrence of code-switching, as noted by Montes-Alcalá (2024). Online learning environments often foster informal, asynchronous exchanges in which students feel more comfortable switching languages compared to traditional classroom settings (Montes-Alcalá, 2024). The flexibility of these platforms creates opportunities for bilingual students to express themselves authentically, facilitating greater engagement with the content and their peers. This is

particularly important in multilingual classrooms where academic language proficiency may vary. Code-switching can thus be viewed as an adaptive strategy that accommodates linguistic diversity and enhances inclusivity in digital education (Mateus, 2014).

Additionally, the concept of translanguaging introduced by García & Wei (2014) further supports the argument that code-switching is integral to the learning process in bilingual environments (Mateus, 2014). Translanguaging emphasizes the fluid use of all available linguistic resources to achieve communication goals, which aligns with current trends in inclusive education. The fluidity of language use in online spaces offers students the freedom to draw from their entire linguistic repertoire, contributing to more meaningful academic and social exchanges. This is particularly relevant in today's context of increasing globalization and multiculturalism, where students often belong to diverse linguistic and cultural backgrounds (Sun & Rong, 2018).

However, it is essential to acknowledge that while code-switching facilitates communication, it can also present challenges in formal academic settings, especially when there is a dominant language of instruction. Studies such as Canagarajah (2011) and Heller (2007) discuss how bilingual students may face tensions between their native language and the academic language of instruction (Canagarajah, 2011; Heller, 2007). In online environments, where the pressure to perform in the language of instruction is high, code-switching might sometimes be seen as a hindrance rather than a tool for learning. However, this is where educational designers and instructors must intervene to create supportive, linguistically inclusive platforms that recognize and valorize code-switching as an asset rather than a challenge.

The findings also have broader implications in light of the growing emphasis on cognitive flexibility among bilinguals. Studies like those by Heller (2007) suggest that bilingual individuals possess superior

cognitive flexibility, enabling them to navigate complex linguistic and social environments (Heller, 2007). In an online learning setting, where students often switch between different tasks, disciplines, and language registers, this cognitive agility plays a vital role in their ability to engage with course content and communicate effectively. The ability to seamlessly switch languages is not only a linguistic skill but a cognitive advantage, contributing to academic success (Bialystok, 2001).

In conclusion, the findings from the reviewed literature confirm that code-switching, especially in online learning contexts, is a significant tool for bilingual students, allowing them to bridge gaps in language proficiency, enhance communication, and navigate diverse academic spaces. The growing recognition of code-switching as a resource in education, coupled with the flexibility of online platforms, presents an opportunity to further explore how multilingual students can benefit from more inclusive, adaptive teaching practices. Future research should continue to examine the impact of such practices on student outcomes, particularly in online and hybrid learning environments, to better support bilingual students' educational journeys.

4. Conclusion

In conclusion, this literature review highlights the significant role of code-switching among bilingual students in online learning environments. The findings reveal that code-switching is not only a natural linguistic behavior but also a strategic tool for communication, enhancing academic engagement and fostering social interaction. As demonstrated in the studies reviewed, bilingual students leverage their linguistic flexibility to bridge gaps in language proficiency, express complex ideas, and negotiate identity in digital spaces. The increasing prevalence of online education, combined with the cognitive benefits of bilingualism and the flexibility of digital platforms, underscores the importance of recognizing code-switching as an asset in multilingual educational settings. Furthermore, the concept of translanguaging offers valuable insights into how bilingual students can draw on their entire

linguistic repertoire for more effective learning and communication.

However, while code-switching provides numerous advantages, it is crucial for educators and instructional designers to create more inclusive learning environments that acknowledge and support this practice. The tension between the academic language of instruction and the home language of bilingual students presents challenges that must be addressed through inclusive pedagogical strategies. As online learning environments continue to evolve, it is essential to explore how code-switching can be integrated into curriculum design, assessment practices, and peer-to-peer interactions in ways that promote both academic success and linguistic diversity.

For future research, it is recommended to conduct empirical studies that explore the direct impact of code-switching on academic performance in online learning contexts. Longitudinal studies could investigate how bilingual students' use of code-switching influences their overall academic achievement, social interactions, and sense of belonging in digital classrooms. Additionally, future research should examine the role of different digital tools and platforms in facilitating or constraining code-switching behaviors. This would provide valuable insights into how the design of online education tools can better support bilingual students and create more inclusive, adaptive learning environments.

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