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ARTICLE

Translanguaging and Content and Language Integrated Learning in Online Education: Rethinking Multilingual Pedagogy

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ABSTRACT

This paper explores the interrelation between multilingualism, translanguaging, and Content and Language Integrated Learning (CLIL)/Integrating Content and Language in Higher Education (ICLHE) within the context of distance and digital learning environments. Drawing on a literature review (2019–2023) and an analysis of international implementations, the study highlights the pedagogical, technological, and social dimensions of CLIL/ICLHE in the era of digital multimodality. Specifically, it emphasizes translanguaging practices as mechanisms for cognitive scaffolding, the reinforcement of student identity, and the promotion of participatory and inclusive learning. This paper demonstrates that the effectiveness of distance CLIL programs depends on the clear alignment between linguistic and cognitive objectives, the continuous professional development of educators, the effective use of multimodal digital tools, and the assurance of digital equity and equal access. Furthermore, it underscores the emerging role of artificial intelligence as a means of providing feedback and supporting adaptive learning, with particular attention to ethical implementation and the cultivation of AI literacy. The findings lead to the formulation of a comprehensive framework based on 5 core research questions for the sustainable integration of CLIL/ICLHE into digital learning ecosystems, where multilingualism and multimodality serve as key drivers of creativity and social inclusion. As such, our study concludes that the future of education is unavoidably multilingual, multimodal, and

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ARTICLE INFO

Received: 20 April 2023 | Revised: 7 June 2023 | Accepted: 14 June 2023 | Published Online: 21 June 2023
DOI: https://doi.org/10.30564/jler.v6i1.12736

CITATION

Gazis, A., Vavouras, T., 2023. Translanguaging and Content and Language Integrated Learning in Online Education: Rethinking Multilingual Pedagogy. Journal of Linguistics and Education Research. 6(1): 38–61. DOI: https://doi.org/10.30564/jler.v6i1.12736

interconnected, demanding innovative pedagogical models that reflect the complex realities of the contemporary knowledge society.

Keywords: CLIL; ICLHE; Translanguaging; Multilingualism; Multimodality; Distance Learning; Digital Learning; Artificial Intelligence

1. Introduction

Globalization and the COVID-19 pandemic have made the use and importance of distance learning highly essential, yet multilingual students face multiple barriers in access, engagement, and equity. In order to address this, CLIL/ICLHE integrates content and language effectively in physical settings, while digital multimodality demands adaptation, thus leveraging translanguaging for cognitive scaffolding and identity support.

Specifically, recent literature from 2019–2023 reveals mixed outcomes, as, based on the analysis presented in the below-mentioned chapters, online CLIL succeeds with multimodal tools (e.g., quizzes, subtitles) but fails in situations without teacher training, monitoring, or linguistic equity. This means that gaps develop and persistently apply in classrooms in frameworks bridging pedagogy, technology, and policy for sustainable digital CLIL/ICLHE.

Before diving into this paper, we must specify that our focus is to provide a top-down approach and explain all the parts that showcase the gaps in existing frameworks and applications (policies) regarding pedagogy, technology, and policymaking for sustainable digital CLIL/ICLHE. Our framework and rationale try to address these by focusing on the following research questions:

1. Why access and learning outcomes in multilingual distance education matter (RQ1);
2. Why translanguaging and multimodality in digital learning environments matter to support content understanding and participation in digital CLIL/ICLHE (RQ2);
3. Why CLIL/ICLHE conditions in a distance learning setting matter (RQ3);
4. Why is language-sensitive course and assessment design essential for inclusion in MOOCs? (RQ4); and
5. Why do socio-emotional factors and social presence shape success for multilingual learners online? (RQ5).

As such, to address these questions, one should provide information regarding the generic frame of the subject. Firstly, migration flows and the widespread use of English as a lingua franca have fostered multilingual and multicultural learning environments. The COVID-19 pandemic further accelerated the adoption of distance and hybrid teaching models, bringing to the forefront the critical issues of digital accessibility, pedagogy, and linguistic support. Within this context, CLIL/ICLHE promotes the integrated teaching of content and language, aiming to develop academic literacy and deepen disciplinary understanding. As such, translanguaging offers a theoretical foundation for leveraging the learner's full linguistic knowledge as a cognitive and communicative resource. Consequently, contemporary perspectives on multilingualism acknowledge the dynamic, repertoire-based use of languages and semiotic resources. Translanguaging thus entails the strategic and flexible deployment of all linguistic means available to the learner for deep understanding and knowledge construction.

CLIL, grounded in its four foundational pillars-Content, Communication, Cognition, and Culture-and its extension as ICLHE in higher education, necessitates explicit language scaffolding, cross-curricular collaboration, and learning-oriented assessment. In digital learning environments, multimodality enables richer, more diverse representations of knowledge and interaction, supporting both comprehension and expression.

As such, this paper can be used as a conceptual framework that applies methodologies and the architectural design principles and objectives of recent literature (2019–2023) on translanguaging and CLIL/ICLHE in digital environments. Specifically, through the analysis of international case studies, it proposes a novice practical framework of operation that incorporates and focuses on pedagogical, technological, and equity challenges rather than strict empirical data collection and analysis.

In recent research, the literature indicates that education systems incorporating multilingual strategies into their official frameworks tend to demonstrate greater resilience

during times of crisis. As Banegas and Porcedda et al. [1,2] observe, Latin American countries exhibited diverse responses to the pandemic, with those that had established bilingual education policies managing to integrate multilingualism more effectively into distance learning contexts.

Accordingly, educational policies and systemic frameworks should prioritize three key areas:

- Ensuring equitable access to digital media, tools, and infrastructure for all learners.
- Embedding multilingual practices within both teaching and assessment processes.
- Providing continuous professional development for educators, with a focus on CLIL, ICLHE, and translanguaging methodologies.

Only through coordinated policies that recognize multilingualism as an asset rather than an obstacle can distance learning become more equitable and effective. This paper investigates the relationship between multilingualism, translanguaging, and integrated language–content instruction (CLIL/ICLHE) within digital learning environments. In the aftermath of the COVID-19 pandemic, distance education has become central to the learning process, redefining conventional modes of teaching and communication. The paper specifically highlights how multilingualism functions as a means of student empowerment and how translanguaging practices can reinforce the holistic learning approach advocated by CLIL. Drawing on recent literature (2019–2023), the analysis seeks to develop proposals for pedagogical and technological frameworks that foster participation, language awareness, and equitable access to knowledge.

The central research questions (RQ) guiding this paper are the following:

- **Main RQ:** *How can multilingualism and translanguaging be integrated into digital CLIL/ICLHE so that learners access content, participate equitably, and achieve strong outcomes?*
- **RQ1:** *Why do access and learning outcomes in multilingual distance education matter, and which structural, linguistic, and design barriers most strongly drive these inequities?*
- **RQ2:** *Why do translanguaging and multimodality matter in digital learning environments and thus improve content understanding and participation in digital CLIL/ICLHE, and under what conditions do they support measurable learning gains?*
- **RQ3:** *Why can CLIL/ICLHE conditions in distance learning settings be redesigned for digitally mediated interaction, assessment, and feedback, and which design choices reduce language bias while preserving academic rigor?*
- **RQ4:** *Why is language-sensitive course and assessment design essential for inclusion in MOOCs, and which scalable supports best reduce dropout and widen participation for multilingual learners?*
- **RQ5:** *Why do socio-emotional factors and social presence shape multilingual learners' success online, and which community-building practices reduce anxiety and sustain engagement over time?*

To address this question, the paper is structured into several thematic sections that reflect the most frequently discussed dimensions of the topic.

Analytically, we begin by examining issues of equal access and learning outcomes, focusing on the challenges and perspectives identified in recent studies that explore both the psychological aspects and the overall educational development of multilingual individuals. Secondly, we showcase translanguaging and multimodal practices in digital spaces, not only by defining the concepts but also by presenting platforms and tools that have emerged through technological advancements. These include digital resources and learning methods that facilitate language acquisition and cross-linguistic understanding.

Thirdly, we explore the application of CLIL/ICLHE in distance learning contexts, emphasizing both practical tools (e.g., quizzes, videos, and interactive whiteboards) and broader systemic issues, including the lack of professional training and unequal technological access. We highlight the need to reinforce, rather than impose, the use of these tools while addressing the absence of standardized evaluation formats.

Fourthly, we examine language-sensitive course design and assessment in open and accessible MOOC platforms, with a particular focus on courses dedicated to language learning. This section also considers how automatic translation and note-taking tools can enhance students' comprehension, engagement, and participation in online courses.

Finally, we present a broader discussion of motivation, emotional engagement, and the sense of social presence in

remote education and the respective policies and suggestions. As such, the paper concludes with a comprehensive framework of operation derived from our analysis. In the following sections, we elaborate on these five thematic questions (5 Why questions) and introduce the proposed framework in detail.

2. Methodological Approach

To develop and propose our framework, this paper is based on research published between 2019 and 2023 on multilingualism, translanguaging, and CLIL/ICLHE in digital and distance learning environments. Our search queries were conducted using known indexing service databases. Analytically, we used Scopus, Web of Science, ERIC, Dimensions, TIB–UB–German National Library of Science and Technology, and Ulrich's International Periodicals Directory. Lastly, we also used broader indexing services such as SCIRUS, EBSCO, Crossref, CNKI, and CiteSeerX. Lastly, we focused on social media publishing platforms such as Academia.edu, ResearchGate, and preprint platforms such as Qeios, arXiv, and MDPI's Preprints. All searches were made using an algorithm of all our query keywords, and then we manually extracted and read the end result. A UML-based analysis and presentation of our Java implementation is provided in **Appendix A**. Also, our search used combinations of the most commonly found keywords of our research, i.e., 'CLIL', 'ICLHE', 'translanguaging', 'multilingual', 'online learning', 'distance education', 'MOOCs', and 'digital multimodality'.

Moreover, our inclusion criteria required that the studies:

- Were peer-reviewed, or at least they were uploaded to a platform with a DOI or another digital identifier.
- The identified papers should be journal articles, book chapters, or major institutional reports.
- Papers should address or outline blended learning contexts or explicitly engage with multilingual learners, translanguaging, or CLIL/ICLHE-related pedagogies.

Similarly, exclusion criteria were:

- No theoretical paper could be included without a connection to digital learning or generally non-educational applications.
- Publications before 2020 were not used unless there was a case-specific need or importance, such as landmark policy reports (e.g., OECD, UNESCO).

3. Research Question 1: Why Do Access and Learning Outcomes in Multilingual Distance Education Matter?

Distance learning, implemented on a large scale following the outbreak of the COVID-19 pandemic, showcased the challenges of ensuring equal access and comparable learning outcomes for multilingual students. Learners from diverse linguistic backgrounds, such as English Language Learners (ELLs) and Multilingual Learners (MLLs), were confronted with situations demanding not only technological familiarity but also sufficient linguistic competence to effectively navigate digital platforms. The transition to online learning environments revealed a dual challenge: on the one hand, technical and socioeconomic barriers, and on the other, language-related obstacles that restricted both participation and academic performance[3–6].

International research has shown that multilingual students were more likely to face connectivity issues, a lack of adequate equipment, and limited support from their family environment, particularly when parents did not speak the language of instruction[7,8]. As a result, this inequality had a direct impact on learning outcomes. In practice, the inability to attend classes in real time, reduced access to individualized support, and introduced difficulties in understanding instructions, which led to lower performance in core subjects, especially mathematics and language[6].

Data from the Organization for Economic Cooperation and Development[4,5] indicates that the pandemic intensified pre-existing educational inequalities. The annual report *Education at a Glance*[4] emphasized that English Language Learners (ELLs) experienced statistically significant learning difficulties, greater than those of their monolingual peers. This observation is supported by findings from the National Center for Education Statistics[9], which revealed that 10.4% of students in the United States are ELLs, one of the groups most vulnerable during the transition to distance learning.

The absence of direct teacher–student interaction further weakened the "scaffolding" mechanisms that traditionally support learners with limited language proficiency in

understanding concepts through examples, visualizations, and continuous feedback[10,11]. In digital learning settings, interaction time was often restricted, rendering these students increasingly dependent on asynchronous materials that were not always linguistically accessible[12,13].

Furthermore, evidence indicates that multilingual students were more likely to disengage or drop out of distance learning. In the World Bank[6], it is noted that participation among Multilingual Learners (MLLs) in online classes declined sharply, primarily because schools failed to provide sufficient multilingual communication channels or bilingual technical support for families. This situation created a vicious cycle: limited access led to reduced participation, resulting in lower performance and, ultimately, a heightened risk of educational exclusion.

The literature also highlights the psychological dimension of this issue. According to Jiang et al.[14], ELLs experienced increased levels of anxiety and diminished motivation in online classes. The inability to use their native language during digital interactions reduced both self-confidence and active participation, especially in contexts where assessment relied heavily on written, linguistically demanding tasks.

At the same time, research stresses that multilingual students do not form a homogeneous group. As Kuzembayeva et al.[15] emphasize, the "visibility" of their needs varies depending on language proficiency, socioeconomic status, and the degree of political or institutional support available at the local level. Consequently, in countries and schools that implemented bilingual support measures, such as parallel language materials, translated instructions, or the presence of language mediators, education, inequalities were mitigated to a greater extent[4,5,16].

A similar picture emerges in higher education. International students and ELLs studying at universities abroad reported lower satisfaction and greater difficulty adapting to digital platforms where learning materials and instruction were exclusively in the target language, without supplementary linguistic support[16,17]. This not only affected their academic performance but also hindered their social integration, as remote learning environments limited the development of interpersonal relationships that often serve as informal support networks.

Reports by the World Bank and UNESCO[6,16] emphasize that the linguistic dimension of distance learning must be embedded within broader educational equity policies. UNESCO, in particular, underscores that incorporating the mother tongue into instruction, even within digital formats, can help reduce learning gaps and promote educational inclusion. However, during the pandemic, most countries lacked the strategies and infrastructure necessary to implement such measures on a large scale.

Overall, the evidence indicates that distance learning functioned as a magnifying lens, exposing and amplifying the inequalities already faced by multilingual students. Technical and socioeconomic barriers, compounded by linguistic challenges, led to increased risks of educational exclusion. These findings confirm the need for future distance learning strategies to consider the multilingual realities of classrooms, not as peripheral factors, but as central components of equity and educational effectiveness.

In conclusion, this section demonstrates that equal access and learning outcomes in distance education cannot be meaningfully assessed without accounting for students' linguistic backgrounds. Multilingual learners require systematic support not only in terms of technological accessibility but also through linguistic and pedagogical adaptation tailored to their diverse needs. A map illustration of the elements explained above is presented in **Figure 1**.

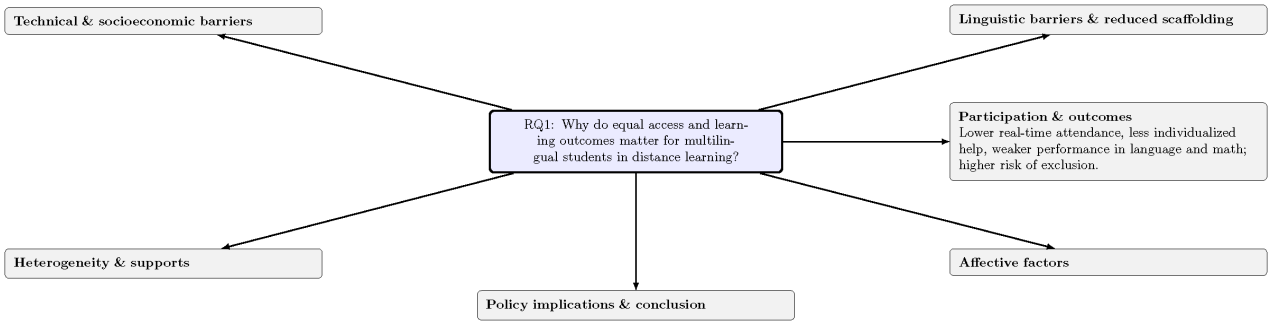

Figure 1. Illustration of RQ1 Properties.

Synthesis and Gaps

As such, in terms of RQ1, across the reviewed studies, we have found convergence that multilingual learners deal with structural barriers. Specifically, this is evident in digital education, especially when platforms and materials are designed for monolingual, highly literate users. Moreover, empirical research has shown that there are also problems, such as limited connectivity, device sharing, and the absence of linguistic support, that augment existing inequalities and lead to lower-than-expected participation and engagement. As such, large-scale policy reports highlight that existing systems that do not consider multilingualism in their remote learning principles tend to reproduce and expand pre-existing learning opportunity gaps.

Similarly, literature suggests that important gaps exist in other areas as well. For example, while many existing studies document ease of access as a decisive factor, relatively few provide longitudinal evidence on monitoring the ways these inequalities evolve over time or across educational levels. Moreover, the lack of comparative research between different contexts and policies does not help clarify which method and action is better, thus which is the optimal and effective plan to follow to mitigate digital exclusion.

4. Research Question 2: Why Translanguaging and Multimodality in Digital Learning Environments Matter?

The concept of translanguaging has become central to contemporary discussions on the education of multilingual students, particularly within the context of distance learning. Unlike traditional notions of bilingualism, which treat languages as separate and self-contained systems, translanguaging acknowledges the holistic and dynamic use of all learners' linguistic resources to construct and convey meaning[18].

Distance learning environments offer new opportunities for the implementation of translanguaging practices, largely due to their inherently multimodal nature. On platforms such as DingTalk, for instance, the fluid switching between languages and communicative modes-text, image, video, and voice-has been shown to enhance comprehension among students with limited proficiency in the target language[10]. The inclusion of multimodal elements enables learners to bridge linguistic gaps and facilitates deeper content retention.

Recent studies by Prilutskaya, Baker and Tsou, and Muguruza et al.[12,13,19], confirm that research on digital translanguaging has expanded exponentially since 2020, with consistent findings demonstrating substantial pedagogical benefits. Translanguaging practices improve access to cognitively demanding subjects while simultaneously supporting target language development through the strategic use of the mother tongue. In asynchronous learning settings, employing multiple languages for explanations, note-taking, and audiovisual materials has been found to significantly increase both comprehension and learner engagement.

International literature emphasizes that translanguaging in digital classrooms serves not merely as a tool for access but rather as a means of empowering students. According to Qin et al.[20], allowing learners to use their native language to explain concepts, collaborate with peers, or record their ideas reduces anxiety levels and strengthens self-confidence. The emotional dimension, particularly the sense of acceptance and affirmation of identity, emerges as a critical factor for academic success. As such, one may consider acknowledging that language anxiety in digital settings is not only related to foreign language learning, but also to cameras and recording if evidence is needed in the different studies conducted. In this way, it is noted that translanguaging-friendly options (e.g., flexible modes of participation and recording) can help learners feel safer and more willing to start engagement with other peers and the instructor, especially when speaking or appearing on camera increases stress.

This highlights the need for digitally mediated CLIL/ICLHE environments to support both linguistic expression and socio-emotional comfort. However, the implementation of such practices is not without challenges. In many cases, educators have struggled to strike an appropriate balance between the target language and students' native languages, expressing concern that excessive reliance on the latter might hinder progress in the former[1]. Nonetheless, research evidence suggests that the intentional and strategic application of translanguaging enhances proficiency in both languages, particularly when integrated within a collaborative and interactive digital environment[18].

The relationship between translanguaging and automatic translation tools is also noteworthy. Research by Malakul and Park[21] on the use of automated subtitles demonstrates that, although such systems remain imperfect, they provide valuable support to multilingual learners by reducing cognitive load and facilitating comprehension. However, the authors stress the importance of educating students to engage with these tools critically and to avoid excessive dependence on them.

The multimodal nature of digital classrooms further enables the implementation of multilingual strategies. For instance, students can use voice messages in their native language to discuss concepts while submitting written assignments in the target language, thereby enhancing both content acquisition and linguistic development[12]. Similarly, findings by Wu and Yu[22] reveal that learners who were able to express themselves in multiple languages on online platforms developed more positive emotional attitudes toward learning. Strengthening these positive emotions through translanguaging practices increased students' resilience to challenges and contributed to improved academic performance.

The integration of translanguaging into digital education is also closely tied to broader questions of social justice. As UNESCO[16] highlights, drawing upon all of students' linguistic resources acknowledges and validates their cultural identities, thereby fostering educational equity. In contrast, the absence of such inclusive approaches risks perpetuating linguistic hegemony and marginalizing learners from diverse linguistic backgrounds.

Overall, this section demonstrates that translanguaging, when combined with multimodal practices, constitutes a success factor in distance education for multilingual learners. Moreover, it reduces anxiety, builds self-confidence, and promotes inclusion by recognizing linguistic diversity as a pedagogical asset rather than a barrier. A map illustration of the elements explained above is presented in **Figure 2**.

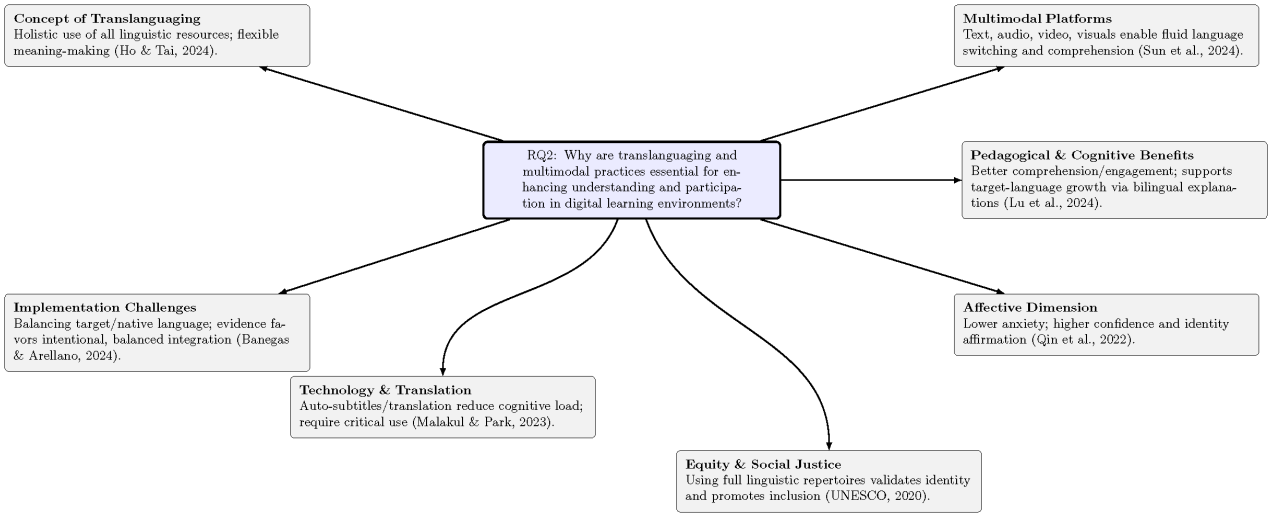

Figure 2. Illustration of RQ2 Properties.

Synthesis and Gaps

As such, in terms of RQ2, the literature suggests that translanguaging and multimodality can act as useful resources for developing positive digital CLIL/ICLHE environments. Specifically, recent studies note that learners are motivated to mobilize their linguistic skills using either L1 for planning, clarification, or peer explanation, and L2 for final outputs, thus reducing their overall anxiety levels. Moreover, the combination of such practices with multimodal texts such as videos/infographics and generally interactive material (e.g., whiteboards) assists students in representing complex concepts in ways more approachable and aligned with their unique cognitive and linguistic methods of thinking.

Similarly, literature suggests that there are some limitations. Analytically, teachers suggest that extensive use of the first language alone may make it more difficult to foster target language development. This notion is ambiguous, as evidence from digital classrooms suggests that strategically structured translanguaging can actually support gains in both

languages, but there is work that needs to be done and prepared for each digital and physical classroom. Furthermore, studies that focus on isolated tools fail to compare in detail the various translanguaging designs and task types; thus, a gap in longitudinal studies exists. The main research gap is how to develop translanguaging and multimodal configurations that affect not only immediate participation but also long-term language proficiency and content learning via a framework of operations or generic, robust, comparative, and longitudinal studies.

5. Research Question 3: Why Do CLIL/ICLHE Conditions in a Distance Learning Setting Matter?

The CLIL (Content and Language Integrated Learning) approach, along with its higher education adaptation, ICLHE (Integrating Content and Language in Higher Education), has emerged as a key pedagogical model for integrating language learning into disciplinary instruction. Within the context of distance education, their implementation has presented both notable challenges and promising opportunities.

Research conducted across different educational settings indicates that the online application of CLIL was often hindered by the absence of a physical classroom and the resulting lack of face-to-face interaction. In Kazakhstan, for example, Kuzembayeva et al. and Sugralina et al. [15,23] found that teachers struggled to sustain the dual focus on content and language in digital environments. Furthermore, the scarcity of suitable digital tools and instructional materials in local languages limited student engagement and participation.

By contrast, a study conducted in China by Yang and Yang [24] evaluated an online CLIL course and reported high levels of student satisfaction, particularly when multimodal tools such as videos, quizzes, and interactive whiteboards were incorporated. These findings suggest that the success of online CLIL largely depends on the quality of instructional design and the effective integration of diverse digital resources.

The lack of professional development for teachers remains a systemic challenge in the implementation of CLIL and ICLHE. According to Banegas [1], CLIL educators in several Latin American countries reported that the shift to distance learning exposed the limitations of their language awareness. Many expressed insecurities regarding their ability to effectively support students online, as they lacked pedagogical strategies for integrating language instruction into virtual environments.

Simultaneously, international literature highlights that CLIL implementation in distance learning contexts is significantly influenced by technological inequalities. The studies, Tao and Gao, and Adamson et al. [25,26], observe that unstable internet connectivity, insufficient technological equipment, and the absence of appropriate digital materials often hinder the effective realization of CLIL principles. Conversely, in cases where there was institutional investment in digital platforms and pedagogical support, students reported more positive experiences and noticeable progress in language development.

The remote application of CLIL/ICLHE also necessitates the adaptation of assessment strategies. In the absence of physical interaction, evaluation should address both language proficiency and content comprehension, emphasizing collaborative and multimodal tasks. Research indicates that blended forms of assessment, such as individual and group assignments, oral presentations, and multimedia projects, are more effective in meeting learners' diverse needs [26,27].

In higher education contexts, the challenges associated with online ICLHE primarily concern academic rigor and cognitive demand. Students reported that studying disciplinary content in a foreign language through distance learning modalities often increased their cognitive load [27,28]. However, evidence suggests that the integration of translanguaging strategies and the provision of bilingual materials can alleviate this burden, promoting both comprehension and engagement.

Comparative research across countries indicates that the success of online CLIL and ICLHE largely depends on the broader educational ecosystem. In systems with an established tradition of CLIL practice, the transition to distance learning was relatively smooth, whereas in contexts lacking prior experience, the challenges were considerably more pronounced [4,5].

In summary, the implementation of CLIL/ICLHE under distance learning conditions has underscored the need for:

- Adaptation of teaching methods to fully exploit the multimodal potential of digital environments.

- Comprehensive training and empowerment of teachers in language awareness and the effective use of digital tools.
- Revision of assessment practices, emphasizing collaboration, multimodal expression, and multilingual support.

The integration of these components can transform the challenges of online CLIL/ICLHE into opportunities for innovative, inclusive, and pedagogically sustainable teaching. A map illustration of the elements explained above is presented in **Figure 3**.

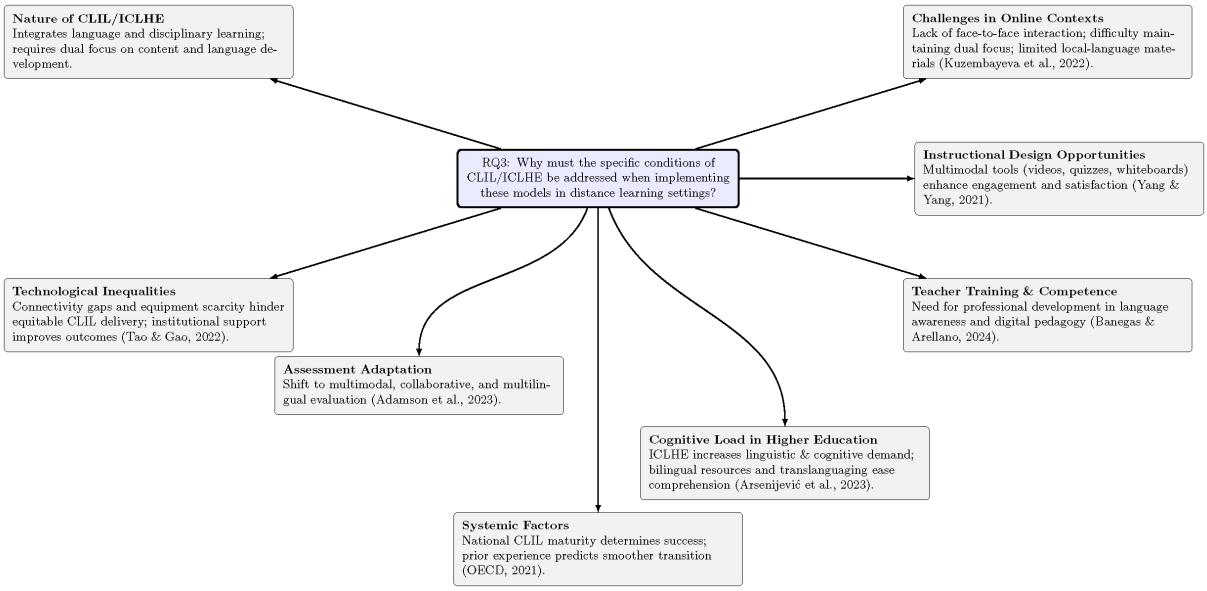

Figure 3. Illustration of RQ3 Properties.

Synthesis and Gaps

As such, in terms of RQ3, the literature shows that CLIL and ICLHE are terms that converge traditional models and cannot be simply transferred in their current form to digital environments. The needed redesign is being documented and focuses on various teachers who state the difficulties and different necessary actions and operations for maintaining a dual focus on content and language. It is difficult to have engagement if no actual redesign principles are applied to simulate or suggest replacements for physical cues, spontaneous interaction, and shared classroom artifacts, which are absent online. As a result, literature shows that various national contexts apply to digital CLIL courses, such as sequencing of input, scaffolded interaction, multimodal resources, and overall ongoing formative assessment.

Similarly, literature showcases that this subject is not adequately studied. Specifically, a large part of the current work focuses on local datasets and experiments during emergency scenarios of remote teaching. This means that attention is limited to sustaining current institutional implementations or comparative evaluation of alternative design models. No actual thought or operations are being made from top to bottom to suggest a new approach. For example, teachers are the sole curricular factor, but not enough research is being done on the role of optimizing the training, from microlearning labs to co-teaching models or design-based mentoring, so as to develop digital CLIL competence.

6. Research Question 4: Why Is Language-Sensitive Course and Assessment Design Essential for Inclusion in MOOCs?

Designing courses for multilingual learners in distance learning environments is a critical area, as it requires balancing clarity, accessibility, and inclusion. Research indicates that digital courses that overlook linguistic diversity inadvertently create barriers to learning, whereas language-sensitive instructional design enhances both participation and academic outcomes [28].

According to Sanchez-Gordon and Luján-Mora [28], accessibility in MOOCs for multilingual learners extends be-

yond technical functionality to encompass linguistic accessibility. Courses that integrate multiple language options, subtitles, and simplified language levels demonstrate higher rates of comprehension and learner persistence.

The use of automatic subtitling and translation tools has become one of the most prevalent means of language support in digital education. The study [21] found that automated subtitles improved content comprehension among students with lower language proficiency by reducing cognitive load and increasing satisfaction. Although such subtitles are not always fully accurate, research consistently shows that they serve as valuable scaffolding tools that enhance accessibility and facilitate engagement.

Assessment in distance learning contexts must likewise consider linguistic diversity. Traditional forms of evaluation, such as written examinations conducted exclusively in one language, often fail to reflect multilingual learners' actual understanding of subject matter [25]. Alternative approaches, including multimodal assignments, video presentations, oral examinations in a preferred language, and collaborative projects, can more effectively capture students' knowledge, skills, and conceptual grasp.

Research indicates that when students are allowed to use their native language for preparation and analysis while presenting their final work in the target language, learning becomes more meaningful and cognitively engaging [12]. This pedagogical approach to leveraging linguistic diversity fosters not only target-language development but also higher-order thinking and critical analysis skills.

Equally significant is the social & emotional learning (SEL) dimension. Studies such as those by Sanchez-Gordon and Luján-Mora and Gitschthaler et al. [28,29] demonstrate that assessment practices incorporating feedback that respects students' linguistic identities increase motivation and reduce anxiety. For instance, teachers who allowed the use of the mother tongue in self-assessment activities reported higher levels of participation and more positive attitudes among learners.

In OECD and UNESCO [4,5,16], the authors emphasize the importance of ensuring that assessment does not operate as a "filter of exclusion." In practice, this entails developing evaluative frameworks that acknowledge and utilize linguistic diversity to facilitate deeper content comprehension. Tools such as bilingual instructions, bridge vocabularies, and adaptive assessment criteria play a vital role in promoting educational equity.

From a pedagogical standpoint, Brooke [27] argues that language-sensitive assessment practices are most effective when linked to collaborative learning. Through collaborative tasks, students exchange knowledge across languages and construct a shared understanding that transcends linguistic boundaries.

Moreover, the integration of adaptive learning technologies can provide personalized pathways for multilingual learners. The study [30] found that international students learning Chinese as a foreign language in digital settings achieved better outcomes when systems offered dynamic language-level adaptation and bilingual instructional support.

Overall, literature underscores that language-sensitive course design and assessment are essential prerequisites for the success of distance education. The integration of translation tools, subtitles, multimodal assignments, and accessibility-oriented policies represents not merely a technical enhancement but a fundamental strategy for ensuring equality, inclusion, and meaningful learning in multilingual digital environments. A map illustration of the elements explained above is presented in **Figure 4**.

Synthesis and Gaps

As such, in terms of RQ4, literature showcases strong agreement regarding the existing processes and practices in digital environments for their focus on mitigating inequalities for multilingual learners. As such, interesting studies have emerged that state that traditional, monolingual written exams are not optimal, as they underestimate the knowledge of students who have not developed the necessary proficiency in the language of instruction, where linguistically dense answers do not allow for multimodal expression. In contrast, research on multimodal assignments, case-specific oral examinations, and portfolio-based assessment suggests a more agile and flexible language-sensitive approach that helps conceptual understanding.

Similarly, literature showcases some limitations. The main research gap is that not many studies focus on the methods and policies to balance content and language and multimodality with restrictions of implementation in large-scale online courses and MOOCs. Also, limited resources expand on how institutions negotiate tensions between existing testing methods and more inclusive assessment practices for several courses of different subjects, from Maths to Language.

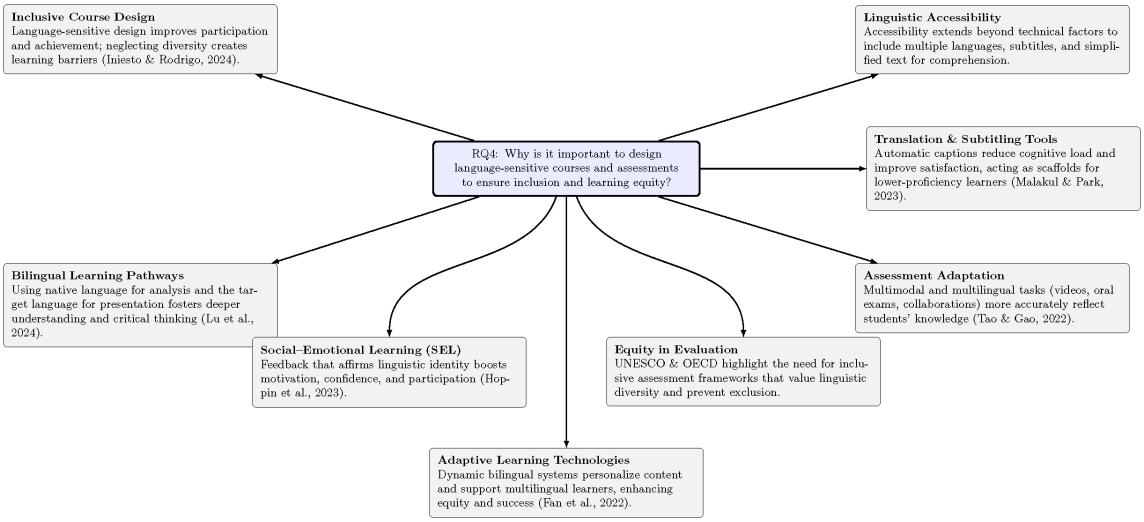

Figure 4. Illustration of RQ4 Properties.

7. Research Question 5: Why Do Socio-Emotional Factors and Social Presence Shape Success for Multilingual Learners Online?

Learning in digital environments depends not only on cognitive and instructional design but also on how students experience the educational process in terms of motivation, emotional well-being, and social presence. Multilingual learners face additional psychological challenges, as distance education can intensify anxiety related to language use and feelings of exclusion.

Empirical research demonstrates that multilingual students often experience heightened anxiety and reduced self-confidence in online learning settings. Studies by Maher and King, Reiber-Kuijpers et al., and de Costa et al. [31–33] confirm that the use of a foreign language in digital environments, where nonverbal cues and physical presence are absent, exacerbates anxiety levels. This emotional strain diminishes active participation and, in turn, negatively impacts learning outcomes.

The psychological dimension is further compounded by the social isolation inherent in distance learning. According to Williams et al. and Themelis [34,35], the absence of a physical classroom weakens the sense of belonging, particularly among students already willing to collaborate and their ability to form social bonds, both of which are marginalized by linguistic differences. As a result, their essential components of effective learning are significantly reduced.

Within this context, the concept of *social presence*, as articulated in the Community of Inquiry model, is especially relevant for multilingual learners. Research by Brooke, Sanchez-Gordon and Luján-Mora. [27,28] indicates that students who experienced a strong sense of social presence in online courses reported higher satisfaction, engagement, and overall academic success. Consequently, strategies designed to enhance interaction, such as group projects, small-group discussions, and collaborative digital tools, are critical for supporting the psychological well-being of multilingual learners.

Social and Emotional Learning (SEL) also plays an essential role. As Gitschthaler et al. [29] note, educators who integrated SEL principles into distance teaching through practices emphasizing empathy, identity recognition, and open communication succeeded in increasing engagement and reducing stress among multilingual students. Acknowledging and valuing students' linguistic and cultural identities proved vital for fostering a psychologically safe and inclusive learning environment.

The motivation of multilingual learners is closely tied to their perception of the value of learning and the extent to which their linguistic identities are acknowledged. The study [22] found that a strong sense of accomplishment positively influences performance in online courses, while Fan and Tian [30] demonstrated that active engagement in digital environments enhances self-efficacy and leads to improved learning outcomes, particularly among international students.

The literature further indicates that modern strategies

that focus on a top-down approach can reduce anxiety and strengthen motivation. According to Qin et al. [20], students with higher levels of readiness for online learning experienced lower anxiety, suggesting that targeted training in digital learning skills can enhance the psychological resilience of multilingual learners.

An additional dimension relates to the use of translation and subtitling tools. The study [21] observed that students who utilized automated translation tools reported feeling more secure, as these resources allowed them to verify comprehension. This increased their confidence and reduced anxiety, contributing to more positive learning experiences.

Overall, this section underscores that the psychological and emotional dimensions are equally as important as the cognitive for the success of distance learning among multilingual students. Social presence, emotional support, and the recognition of linguistic identity constitute essential factors that enhance motivation, reduce stress, and promote sustained engagement. A map illustration of the elements explained above is presented in **Figure 5**.

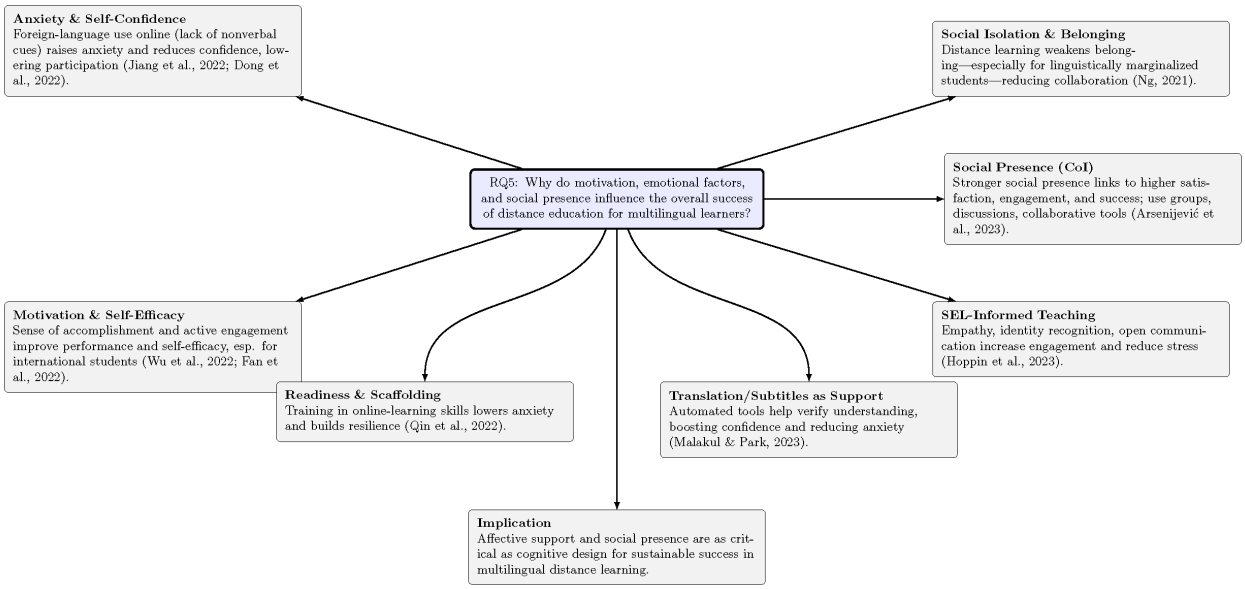

Figure 5. Illustration of RQ5 Properties.

Synthesis and Gaps

As such, in terms of RQ5, emotional factors and social presence are key factors to the success of multilingual learners in digital online education. Research suggests that anxiety linked to foreign language use is strengthened in digital environments where visual cues are reduced, thus interaction can feel more surveilled. Moreover, research showcases that when courses deliberately cultivate social presence, e.g., through collaborative tasks, discussion forums, and synchronous small-group work, students score higher on scales of engagement and have a stronger sense of belonging.

Similarly, literature showcases that improved learning outcomes are the objective, but the complexity of researching them is not simple. For example, most of the studies rely on self-reporting, thus making it difficult to trace specific emotions and social connections that help develop a course or an educational program.

8. Discussion, Policies, and Suggestions

The experience of the COVID-19 pandemic and the abrupt transition to distance learning underscored the need not only for pedagogical adaptation but also for policy and systemic interventions that explicitly account for multilingualism. International organizations consistently emphasize that educational equality cannot be achieved without strategies that recognize and respond to linguistic and cultural diversity [4,5,16].

UNESCO's *Global Education Monitoring Report* [16] highlights that the inclusion of all students (regardless of lan-

guage) is a prerequisite for the sustainable development of societies. The use of the mother tongue in education, including in digital contexts, is considered essential for preventing learning exclusion. Nevertheless, only a limited number of education systems successfully implemented bilingual support mechanisms during the pandemic.

The reports [4,5] found that "emergency distance learning" disproportionately affected multilingual and socioeconomically disadvantaged groups. It further stresses the necessity of systematic teacher training in CLIL and translanguaging methodologies to ensure that educators can effectively support learners from diverse linguistic backgrounds.

Similarly, the World Bank [6] underlines that the future resilience of education systems depends on their ability to create mechanisms guaranteeing equitable access to digital resources for all students. This includes not only technological infrastructure, such as stable internet access and adequate devices, but also linguistic accessibility, including multilingual technical support, translated materials, and bilingual learning platforms.

In this context:

- The political dimension of multilingualism extends beyond classroom practice to national and international education strategies. As Adamson et al. [26] emphasize, CLIL and ICLHE initiatives cannot be sustained without strong institutional backing, adequate funding, and continuous teacher training. The absence of these conditions limits both the effectiveness and the long-term viability of such programs.
- The integration of translanguaging and multimodality offers tangible pathways toward inclusive digital learning. Multimodal compositions, such as videos, podcasts, and infographics, document how students think, reflect, and construct knowledge. The use of bilingual documentation (for example, note-taking in the first language and final deliverables in the target language with subtitles) reduces stress and enhances academic precision.
- The assessment design should align with the dual objectives of content mastery and language development. Recommended rubrics may allocate approximately 60–70% of the weight to content understanding and 30–40% to language and multimodality. Low-stakes formative micro-tasks, e-portfolios, and peer assessment using simplified checklists are suggested as inclusive and reliable approaches.
- The teacher training should cultivate triple competence: scientific, linguistic, and digital. Microlearning laboratories, collaborative learning circles, and pair-mentoring models that combine content specialists with language specialists represent effective training frameworks.
- In terms of equality and accessibility, adherence to *WCAG 2.1* standards is essential. Key practices include providing subtitles and transcripts, alt-text for visuals, low-size downloadable files, and multiple participation pathways (chat, voice, and written). Flexible deadline policies and explicit codes of conduct for the ethical use of AI further contribute to equitable participation in digital learning environments.

9. Proposed Framework for Operation and Activities

The role of the teacher in digital CLIL/ICLHE environments shifts from that of a knowledge transmitter to that of a learning-experience designer. Instruction is organized in short, iterative cycles that include brief input, guided practice, collaborative exploration, and reflection. Translanguaging functions as a bridge between comprehension and production using bilingual glossaries, sentence frames, L1/L2 captions, and concept maps.

9.1. Proposed 8-Step Framework for Digital CLIL/ICLHE

Building on the *five key questions* (**Figure 6**) discussed earlier, we propose an eight-step framework for designing and implementing digital CLIL courses:

1. Diagnostic Test: Identify learners' language and content baselines.
2. Declared Content and Language Objectives: Make learning goals explicit from the outset.
3. Pre-Teaching of Terminology: Use micro-videos, glosses, and visual scaffolds.
4. Controlled Input: Provide guided tasks that model both content and language.
5. Transformative Activities (DMC): Engage learners in producing multimodal, creative outputs.
6. Collaborative Inquiry: Structure group work with de-

fined linguistic and cognitive roles.

7. Formative Feedback: Offer iterative feedback, supported by digital tools and peer review.
8. E-Portfolio Assessment: Evaluate learning through rubrics addressing content, language, and multimodality.

The framework proposed above is presented in **Figure 7**.

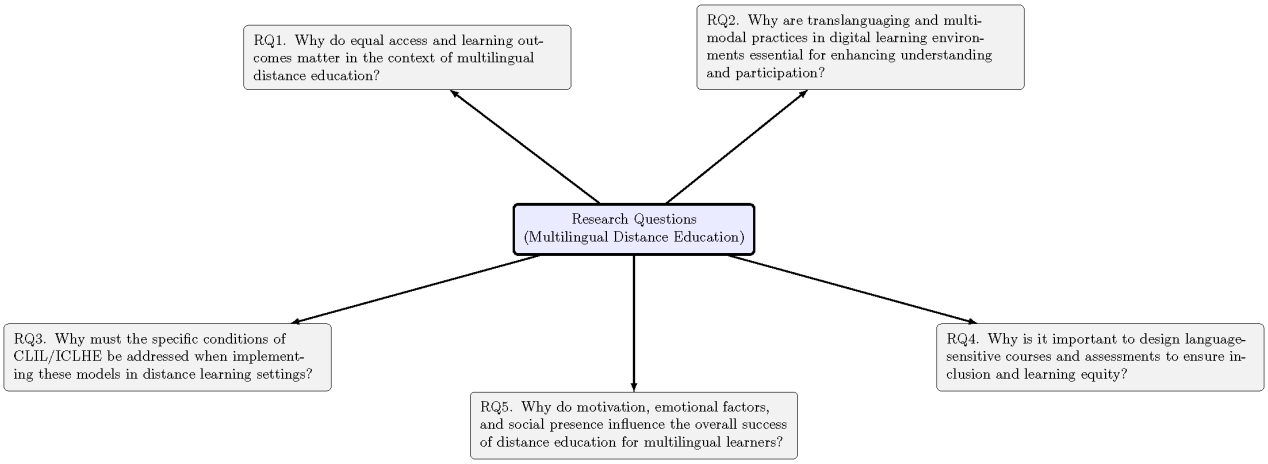

Figure 6. Research Framework for Multilingual Distance Education (RQ1–RQ5).

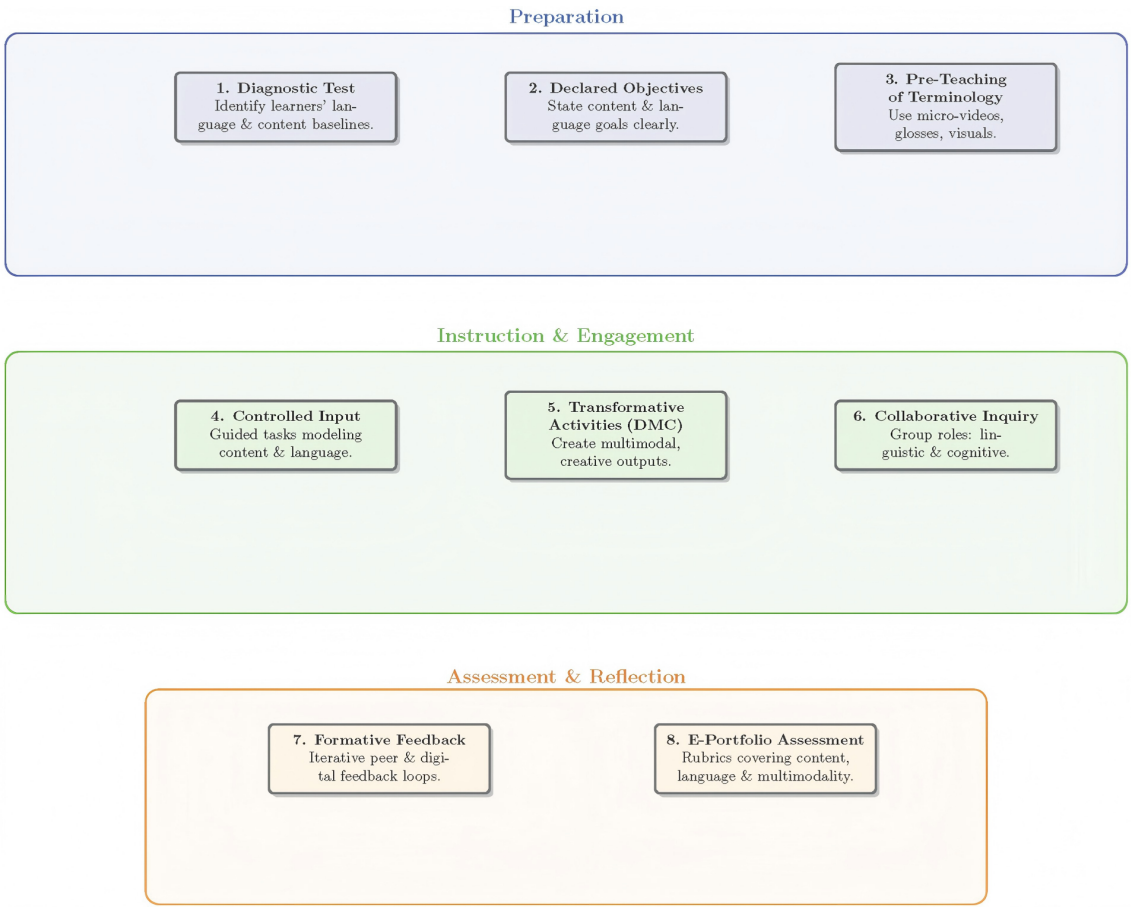

Figure 7. Illustration of the Suggested 8-Step Framework for Digital CLIL/ICLHE.

9.2. Illustrative Mini-Cases and Institutional Policy Framework

9.2.1. Mini-Case A (RQ1): Reducing Unequal Access/Participation in a Multilingual Online Course

During the first year of an online course with multilingual learners, unequal participation was noted as students of lower academic language confidence posted less in forums, regularly misunderstood instructions, asked for more information on the subject and specifications of terms, and disengaged when tasks assumed a native-like expected speed of answers and/or digital familiarity with existing platforms.

The instructor should observe these barriers and understand that they are not linguistic but more structural (i.e., unclear navigation, fast-paced discussions, etc.), thus trying to assess the students' needs and provide more time and effort for the ones struggling to adapt and flourish. As such, using our proposed framework can help redesign the course with language-sensitive task briefs (plain language, simple terms, and lots of examples), multimodal access (brief overviews of videos, subtitles, and transcripts), and flexible participation modes (text/audio/visual replies and participation). In this way, small group discussion will be introduced with roles and turn-taking prompts, and more regular check-ins.

9.2.2. Mini-Case B (RQ2): Translanguaging and Multimodal Task Design in Digital CLIL

In another case study, imagine an online CLIL science module where learners need to explore a short-duration video on Kirchhoff's circuit laws with captions in the targeted language and optional subtitles in their L1. As such, they should work in small groups using breakout rooms, where they shall discuss in detail key concepts and areas of improvement in their preferred language and try to develop a concept map combining L1 notes and L2 keywords in a class forum. The participation will become uneven when confident learners dominate, while others rely solely on copying or avoid contributing for fear that their language will not allow them to understand and explain the content.

Our framework would suggest a course implementation of a translanguaging-friendly workflow where learners brainstorm and collaborate in their languages during drafting. Afterwards, they will produce a final multimodal artifact that will include both academic terms in the final target language and some elements of infographics, short narration, or slides of unordered lists (words, not full sentences). As such, this will help provide sentence starters for academic function and structure feedback during the language refinement of the final deliverable. This will help increase participation and thus help evolve the necessary language skills and confidence.

9.2.3. Mini-Case C (RQ3): Redesigning Assessment and Feedback in Digital ICLHE

Another interesting case study would be a postgraduate ICLHE course delivered remotely and online, where the teacher replaces the written final exam with a sequence of assessments. These are shorter, weekly, and rely more on micro tasks, collaborative projects, and individual work and assessment. Students will receive audio or video feedback with comments separately on reasoning and language, while they will be encouraged to respond in either L1 or L2 based on the feedback.

Our framework would suggest redesigning the course with a case-specific rationale to showcase the importance. Firstly, students must understand the topic, then have a general outline, and then try to focus on drafting and revision to provide the final deliverable. This means that with feedback loops at each of these steps and short formative quizzes on key areas, they can improve the quality of their final work. Some methods could be rubrics sent separately from language-support criteria, and students being allowed to submit multimodal evidence to reduce possible language bias. As such, iterative feedback will help them concentrate on the task and not on the language barriers based on their linguistic skills.

9.2.4. Mini-Case D (RQ4): Language-Sensitive MOOC Redesign

During a large open MOOC on digital literacy, after the completion of the course, it is noted that the completion percentage is significantly lower for self-reported individuals with L2 proficiency at an intermediate level or below. The redesign introduces more simplified language tracks for key concepts and the course, subtitles in more than one language, and glossaries with L1–L2 terminology and concepts for

each of these languages. Another step could be the use of short orientation videos explaining how to use and navigate the platform in an accessible language.

Our framework would suggest redesigning the assessment to focus on language-sensitive scaling, i.e., using a more plain-language approach with lots of summaries, key concepts, focus on improving the captions and transcripts, and keyword glossaries for terms and subjects. Moreover, guided discussion prompts with model answers could help with participation, while peer assessment would simplify the rubrics and examples, and optional language-support tracks could be added to support learners. As such, the expected outcome would be a course with higher completion rates or even better tracking numbers due to a more inclusive participation approach, as the language barriers will be reduced through assessment and feedback.

9.2.5. Mini-Case E (RQ5): Social Presence and Socio-Emotional Support for Multilingual Learners

Following the previous case study, let's imagine a blended language-across-the-curriculum course. The instructor opens each week with a brief check-in poll and an anonymous digital whiteboard (e.g., Miro or Padlet) where students can share feelings or concerns in any language. The students will be hesitant to speak for fear of negative evaluation of their accents or grammar mistakes. As such, they will feel socially isolated and will experience anxiety during participation and a lack of community engagement.

Our framework would suggest augmenting their linguistic comfort by shifting the course to have a stronger social presence through structured, low-risk community practices. Some examples can be welcome videos, clear methods on feedback and respectful interactions, early anonymous contributions, and smaller mixed buddy groups for meet-and-greet activities. As such, the instructor would increase engagement via weekly check-ins, supportive feedback tone across all activities, and thus help promote equitable participation and improved persistence online.

9.2.6. Institutional Policy Framework Proposal

Similarly, several potential mini-case studies can be developed and applied in future digital CLIL/ICLHE implementations. Indicatively, the most notable ones may include the following:

- ICLHE Management: Conduct a SWOT analysis using bilingual vocabulary, followed by a video pitch.
- CLIL Natural Sciences: Explore the water cycle through captioned visuals and a short podcast.
- COIL (Collaborative Online International Learning): Facilitate international teamwork culminating in a research brief and visual abstract.

As for the *Institutional policy framework*, the main aim must be to sustain innovation; institutions should adopt a structured CLIL/ICLHE policy that includes a guide for course design, a shared lesson-plan repository, micro-grants for developing Digital Multimodal Content, peer-observation schemes, and recognition of additional workload for teachers engaged in bilingual and multimodal teaching.

9.3. Core Principles of the Framework

As such, following our analysis, the core principles of the proposed framework based on our studies are the following:

- **Integrated Linguistic Ecology:** The digital classroom functions as an ecosystem of signs. The teacher orchestrates speech, image, and sound to create a coherent multimodal learning experience. Translanguaging acts as a community mechanism, L1 for negotiation, L2 for final production, and multimodality for visibility of thought.
- **Identity and Participation:** Participatory multilingualism promotes role differentiation (e.g., note-taker in L1, presenter in L2) and diverse forms of expression (chat, audio, video). This reduces exclusion and enhances immersion.
- **Emotional Dimension:** Targeted well-being interventions, such as check-ins, anonymous feedback, and socialization spaces, help reduce L2 anxiety and improve persistence in cognitively demanding tasks.
- **Intercultural Competence and COIL:** International collaborative projects create authentic contexts for L2 use supported by L1, fostering intercultural sensitivity and negotiation of meaning.
- **AI and the Future of CLIL:** Adaptive feedback systems, automated text analysis, and real-time subtitles

expand the pedagogical toolkit.

- **AI literacy** cultivation and promoting **ethical AI use** are also essential for sustainable integration.

10. Conclusions

The success of online CLIL/ICLHE depends on transparent objectives, reflective multimodality, participatory multilingualism, and technological ethics. Achieving these goals requires inclusive policy frameworks, sustained training, and open repositories of multimodal materials. Ultimately, the future of education is multilingual, multimodal, and interconnected, i.e., a vision in which diversity is not a challenge to overcome but a foundation for innovation, equity, and creativity.

Our literature review demonstrates that distance learning for multilingual students constitutes a multidimensional challenge. From ensuring equal access to addressing psychological well-being, multilingualism emerges as a central factor that cannot be disregarded. Based on the analysis of the five "Why" research questions, our research findings indicate that:

- Multilingual learners faced increased barriers in accessing and understanding content.
- Translanguaging and multimodality practices serve as powerful tools for enhancing learning.
- CLIL and ICLHE models must be adapted to digital environments, and teachers require systematic training.
- Language-sensitive lesson design and assessment improve inclusion and learning outcomes.
- Social presence and emotional support are essential for motivating multilingual learners.
- Policies and institutional strategies must systematically integrate multilingualism at all levels of education.

Overall, multilingualism should be regarded not as a barrier but as an *asset*. Its integration within distance learning environments fosters educational equity, enhances academic performance, and supports the development of inclusive and sustainable learning ecosystems. This study can serve as a foundation for a deeper understanding of how remote education functions and how a theoretically grounded framework can guide policy formulation for MOOCs and other online learning models.

Specifically, future research should focus on: (a) the measurable impact of translanguaging on learning outcomes; (b) the reliability and validity of multimodal assessment rubrics; (c) randomized controlled trials evaluating the effectiveness of AI-based feedback tools; and (d) longitudinal analyses of linguistic identity development and professional competence within multilingual digital learning contexts for teachers.

Author Contributions

Conceptualization, T.V. and A.G.; methodology, T.V.; software, A.G.; validation, T.V.; formal analysis, T.V.; investigation, T.V.; resources, A.G.; data curation, A.G.; writing—original draft preparation, A.G.; writing—review and editing, A.G. and T.V.; visualization, A.G.; supervision, T.V.; project administration, T.V. All authors have read and agreed to the published version of the manuscript.

Funding

This work received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

No new data were created or analyzed in this study. Data sharing does not apply to this article.

Conflicts of Interest

The authors declare no conflict of interest.

Appendix A

The Java generic abstract algorithm developed to scan through various indexing databases was the following:

Algorithm A1. The Java generic abstract algorithm.

```
public class LiteratureSearchPipeline {

   /* ============================
     Domain model used for our search
     ============================ */

   public record BibRecord(
         String title,
         String abstractText,
         List<String> authors,
         int year,
         String sourceName,
         String docType,      // journal_article | book_chapter | report |
preprint | other information can be added as well
         String doi,
         String otherId,      // arXiv id, handle, etc.
         List<String> keywords,
         String url,
         boolean peerReviewed // if known; otherwise false (still allowed to
be used only with DOI/ID)
   ) {}

   public record SourceQuery(String queryString, int yearFrom, int
yearTo) {}

   public interface SourceConnector {
      String sourceName();
      List<BibRecord> search(SourceQuery query);
      default boolean isPrimaryIndex() { return true; }
   }

   public interface QueryStrategy {
      List<SourceQuery> buildQueries(List<String> keywordBank, int
yearFrom, int yearTo);
   }

   public interface RecordNormalizer {
      BibRecord normalize(BibRecord raw);
   }

   public interface DeduplicationStrategy {
      List<BibRecord> dedupe(List<BibRecord> records);
   }

   public interface ScreeningPolicy {
      boolean include(BibRecord r);
      boolean exclude(BibRecord r);
      default boolean isEligible(BibRecord r) { return include(r)
&& !exclude(r); }
   }

   public interface ManualScreeningQueue {
      void enqueue(List<BibRecord> candidates);
      void exportCsv(List<BibRecord> candidates, Path path) throws
IOException;
   }

   public record RunResult(
         int rawCount,
         int normalizedCount,
```

```
        int uniqueCount,
        int eligibleCount,
        List<BibRecord> eligible
    ) {}

    /* ============================
       Main Pipeline of processes and operations
       ============================*/

    private final List<SourceConnector> sources;
    private final QueryStrategy queryStrategy;
    private final RecordNormalizer normalizer;
    private final DeduplicationStrategy deduper;
    private final ScreeningPolicy policy;
    private final ManualScreeningQueue manualQueue;

    public LiteratureSearchPipeline(
        List<SourceConnector> sources,
        QueryStrategy queryStrategy,
        RecordNormalizer normalizer,
        DeduplicationStrategy deduper,
        ScreeningPolicy policy,
        ManualScreeningQueue manualQueue
    ) {
        this.sources = Objects.requireNonNull(sources);
        this.queryStrategy = Objects.requireNonNull(queryStrategy);
        this.normalizer = Objects.requireNonNull(normalizer);
        this.deduper = Objects.requireNonNull(deduper);
        this.policy = Objects.requireNonNull(policy);
        this.manualQueue = Objects.requireNonNull(manualQueue);
    }

    public RunResult run(List<String> keywordBank, int yearFrom, int
yearTo, Path exportCsvPath) throws IOException {
        var queries = queryStrategy.buildQueries(keywordBank, yearFrom,
yearTo);

        var raw = sources.stream()
                .flatMap(src -> queries.stream().flatMap(q ->
src.search(q).stream()))
                .toList();

        var normalized = raw.stream()
                .map(normalizer::normalize)
                .toList();

        var unique = deduper.dedupe(normalized);

        var eligible = unique.stream()
                .filter(r -> r.year() >= yearFrom && r.year() <= yearTo)
                .filter(policy::isEligible)
                .toList();

        manualQueue.enqueue(eligible);
        manualQueue.exportCsv(eligible, exportCsvPath);

        return new RunResult(raw.size(), normalized.size(), unique.size(),
eligible.size(), eligible);
    }

    /* ========================================
       Abstract  & Generic default components presentation
       ======================================== */

    public static QueryStrategy defaultQueryStrategy() {
        return (keywordBank, yearFrom, yearTo) -> {
```

```
            var big = keywordBank.stream()
                    .map(k -> k.contains(" ") ? "\"" + k + "\"" : k)
                    .collect(Collectors.joining(" OR "));

            return List.of(
                    new SourceQuery(big, yearFrom, yearTo),
                    new SourceQuery("(CLIL OR ICLHE) AND (online OR
distance OR digital OR blended)", yearFrom, yearTo),
                    new SourceQuery("translanguaging AND (MOOC OR
MOOCs OR \"online learning\" OR \"distance education\")", yearFrom,
yearTo),
                    new SourceQuery("multilingual AND (multimodality OR
\"digital multimodality\")", yearFrom, yearTo)
            );
        };
    }

    public static RecordNormalizer defaultNormalizer() {
        Function<String, String> norm = s -> s == null ? "" :
s.trim().replaceAll("\\s+", " ");

        Function<List<String>, List<String>> normList = xs -> xs == null ?
List.of()
                : xs.stream().filter(Objects::nonNull).map(norm).filter(s -
> !s.isBlank()).distinct().toList();

        return r -> new BibRecord(
                norm.apply(r.title()),
                norm.apply(r.abstractText()),
                normList.apply(r.authors()),
                r.year(),
                norm.apply(r.sourceName()),
                norm.apply(r.docType()).toLowerCase(Locale.ROOT),
                norm.apply(r.doi()).toLowerCase(Locale.ROOT),
                norm.apply(r.otherId()).toLowerCase(Locale.ROOT),
                normList.apply(r.keywords()).stream().map(s ->
s.toLowerCase(Locale.ROOT)).toList(),
                norm.apply(r.url()),
                r.peerReviewed()
        );
    }

    public static DeduplicationStrategy defaultDeduper() {
        return records -> {
            var byDoi = new LinkedHashMap<String, BibRecord>();
            var noDoi = new ArrayList<BibRecord>();

            records.forEach(r -> {
                var doi = Optional.ofNullable(r.doi()).orElse("").trim();
                if (!doi.isBlank()) byDoi.putIfAbsent(doi, r);
                else noDoi.add(r);
            });

            // Title & year key for those that do not have a DOI (also added
other criteria, this is the generic key value and approach used)
            Function<BibRecord, String> titleYearKey = r ->

(Optional.ofNullable(r.title()).orElse("").toLowerCase(Locale.ROOT) +
"::" + r.year())
                        .replaceAll("[^a-z0-9:]+", "");

            var byTitleYear = new LinkedHashMap<String, BibRecord>();
            noDoi.forEach(r ->
byTitleYear.putIfAbsent(titleYearKey.apply(r), r));

            return new ArrayList<BibRecord>() {{
```

```
            addAll(byDoi.values());
            addAll(byTitleYear.values());
        }};
    };
  }

  public static ScreeningPolicy defaultPolicy() {
    Predicate<BibRecord> hasPersistentId = r ->
        (r.doi() != null && !r.doi().isBlank()) || (r.otherId() != null
&& !r.otherId().isBlank());

    Set<String> allowedTypes = Set.of("journal_article",
"book_chapter", "report", "institutional_report");

    Predicate<BibRecord> allowedDocType = r -> {
      var t =
Optional.ofNullable(r.docType()).orElse("").toLowerCase(Locale.ROOT);
      if (allowedTypes.contains(t)) return true;
      //The aim is to be permissive if docType is missing, but looks like
a major report/journal item in practice, even though the result will be read
manually as well, trying to develop outliers to filter our results:
      return !t.isBlank() && (t.contains("journal") ||
t.contains("chapter") || t.contains("report"));
    };

    Predicate<BibRecord> hasDigitalContext = r -> {
      var text = (Optional.ofNullable(r.title()).orElse("") + " " +
          Optional.ofNullable(r.abstractText()).orElse("") + " " +
          String.join(" ",
Optional.ofNullable(r.keywords()).orElse(List.of())))
          .toLowerCase(Locale.ROOT);

      return Stream.of("online", "distance", "digital", "mooc", "moocs",
"blended", "virtual", "e-learning", "elearning")
          .anyMatch(text::contains);
    };

    Predicate<BibRecord> hasTopic = r -> {
      var text = (Optional.ofNullable(r.title()).orElse("") + " " +
          Optional.ofNullable(r.abstractText()).orElse("") + " " +
          String.join(" ",
Optional.ofNullable(r.keywords()).orElse(List.of())))
          .toLowerCase(Locale.ROOT);

      return Stream.of("clil", "iclhe", "translanguaging", "multilingual",
"multilingualism", "multimodality", "multimodal")
          .anyMatch(text::contains);
    };

    Predicate<BibRecord> nonEducationalOrNoDigitalLink = r -
> !hasDigitalContext.test(r); // generic proxy presentation
    Predicate<BibRecord> theoryOnlyNoDigitalLink = r -
> !hasDigitalContext.test(r) && hasTopic.test(r);

    return new ScreeningPolicy() {
      @Override
      public boolean include(BibRecord r) {
        // peer-reviewed OR it has DOI/ID
        var idOk = r.peerReviewed() || hasPersistentId.test(r);
        return idOk && allowedDocType.test(r) &&
hasDigitalContext.test(r) && hasTopic.test(r);
      }

      @Override
      public boolean exclude(BibRecord r) {
        // Exclude if it doesn't connect to digital learning (or is theory-
```

```
only, i.e., without a digital link)
            return nonEducationalOrNoDigitalLink.test(r) ||
theoryOnlyNoDigitalLink.test(r);
        }
    };
  }

  public static ManualScreeningQueue defaultManualQueue() {
    return new ManualScreeningQueue() {
      @Override
      public void enqueue(List<BibRecord> candidates) {
        // Intentionally empty: represents “manual extraction & reading”
stage in the paper. We have added this to showcase the rationale and flow
of our operations
      }

      @Override
      public void exportCsv(List<BibRecord> candidates, Path path)
throws IOException {
        Files.createDirectories(path.toAbsolutePath().getParent());
        try (BufferedWriter w = Files.newBufferedWriter(path)) {
          w.write("title,year,docType,doi,otherId,sourceName,url\n");
          candidates.forEach(r -> {
            var line = csv(r.title()) + "," + r.year() + "," +
csv(r.docType()) + "," +
                csv(r.doi()) + "," + csv(r.otherId()) + "," +
csv(r.sourceName()) + "," +
                csv(r.url()) + "\n";
            try { w.write(line); } catch (IOException e) { throw new
RuntimeException(e); }
          });
        }
      }

      private String csv(String s) {
        var v = Optional.ofNullable(s).orElse("").replace("\"", "\"\"");
        return "\"" + v + "\"";
      }
    };
  }
}
```

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