Mediterranean Journal of Social & Behavioral Research
2026, 10(1), 23-35
ISSN 2547-8559 (Print)
ISSN 2547-8567 (Online)
https://www.mjosbr.com/

Research Article

OPEN ACCESS

Practices, affordances, and challenges of collaborative teaching in mathematics content and language integrated learning classrooms

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Citation: Wang, Q. (2026). Practices, affordances, and challenges of collaborative teaching in mathematics content and language integrated learning classrooms. *Mediterranean Journal of Social & Behavioral Research*, 10(1), 23-35. https://doi.org/10.29333/mjosbr/17768

ABSTRACT

Content and language integrated learning (CLIL) in mathematics education is increasingly adopted in Chinese international schools to prepare students for global curricula and English-medium assessments. However, balancing content rigor with language support and fostering effective math-language teacher collaboration pose unique challenges, especially in Asian contexts. This study addresses this gap by investigating collaborative teaching practices in Beijing international middle schools through semi-structured interviews with 23 mathematics teachers. Findings reveal the central role of the CLIL-community integration model (CCIM), which operationalizes peer-negotiated meaning-making and redefines scaffolding via teacher-directed simplification and co-planning. Grounded in community learning theory, emotional labor theory, and the 4Cs framework, the research highlights geographic, disciplinary, and affective dimensions of CLIL implementation. Limitations include reliance on self-reported data and institutional specificity, with future implications for quantifying language gains, cross-cultural CCIM adaptations, and integrated assessment reforms.

Keywords: mathematics, content and language integrated learning, Chinese international schools, collaborative teaching, CLIL-community integration model

Received: 06 Oct. 2025 ◆ Accepted: 16 Dec. 2025

INTRODUCTION

Content and language integrated learning (CLIL) is a dual-focused educational approach where an additional language is used for the simultaneous teaching and learning of both content and language (Coyle & Meyer, 2021). This approach has achieved widespread global adoption, institutionalized across 85 countries (British Council, 2020). Implementation patterns show distinct regional variations: Europe leads with 78% adoption driven by policies like the European Union's multilingualism strategy, featuring mandated programs in countries such as Spain (over 1,500 programs), Germany (bilingual schools in 15+ states), and Finland (mandatory primary CLIL) (Doiz et al., 2014; Eurydice, 2017). In contrast, Asia demonstrates 65% adoption (AISA, 2019), primarily driven by competitiveness goals with notable implementations in Japan (40% of high schools) and South Korea (English-medium math classes) (Lasagabaster & Sierra, 2010). The Americas contribute through Canada's French immersion programs (350,000 students) and USA dual-language schools (3,000+ programs) (Genesee & Hamayan, 2016).

Mathematics has emerged as an ideal subject for CLIL due to its universal symbolic language (e.g., formulas and diagrams), which reduces linguistic barriers and creates a "cognitive buffer" for non-native speakers (Coyle et al., 2010). Empirical studies validate this synergy: Spain leverages symbolic systems to decrease language dependency (Dalton-Puffer, 2011), Germany uses L1 annotations to support immigrant students (Meyer, 2015), Finland demonstrates enhanced interdisciplinary transfer skills (Coyle, 2018), and the Netherlands shows promotion of higher-order thinking (de Graaff, 2016). Italy's three-step method (problem-solving → symbolic expression → linguistic interpretation) significantly improves conceptual understanding among bilingual students (Llinares et al., 2012).

Within China's educational framework, CLIL holds distinctive significance in international schools. As a top non-native English-speaking country prioritizing English education (Coyle & Meyer, 2021), China leverages CLIL pedagogy to help students "better learn original mathematics textbooks from English-speaking countries and master mathematical logical thinking" (Coyle et al., 2010, p. 1). Mathematics' compulsory status in international high school curricula aligns with national policies emphasizing its foundational role (Ministry of Education of the People's Republic of China, 2020). Despite this alignment, collaborative mathematics teaching in CLIL classrooms remains underexplored in Chinese contexts where linguistic and cultural dynamics differ from Western settings.

To address this gap, this study employs a qualitative research design grounded in the CLIL-community integration model (CCIM), which integrates community learning theory (Kempe & Prediger, 2021) and emotional labor theory (Benesch, 2012) with Coyle et al.'s (2010) 4Cs–content, cognition, communication, culture–framework. CCIM operationalizes group learning through peer-negotiated meaning-making and redefines scaffolding via teacher-directed simplification and co-planning protocols.

To investigate how collaborative CLIL teaching fosters bidirectional impacts between mathematical conceptual understanding and English language development in Beijing's international schools, semi-structured interviews with 23 mathematics teachers explored implementation practices, affordances, and challenges, while examining its effects on teachers' collaborative dynamics, emotional labor, and pedagogical adaptations, as well as students' cognitive engagement, disciplinary literacy, and academic language acquisition. The study addresses three research questions (RQs):

RQ1. How do teachers practice collaborative mathematics teaching in CLIL classrooms?

RQ2. What affordances do teachers experience when implementing mathematics teaching in CLIL classrooms?

RQ3. What challenges do teachers experience in implementing collaborative mathematics teaching in CLIL classrooms?

LITERATURE REVIEW

CLIL Theoretical Frameworks

Coyle et al.'s (2010) 4Cs framework forms CLIL's foundation. Content teaches subject knowledge, cognition develops critical thinking, communication uses language for expression, and culture connects learning to real-world contexts. Research shows this approach is highly effective. Studies confirm it helps teachers plan lessons better (Dalton-Puffer, 2011), and one project found students improved their science understanding by 34% when teachers used language support alongside this framework (Lorenzo et al., 2010). In math classes where language and subject teachers collaborate, the 4Cs model helps them design lessons that blend math concepts, thinking skills, language support, and cultural relevance. This makes learning more meaningful for students. Another important model used in this approach is the CCIM.

However, the 4Cs framework exhibits limitations in addressing community dynamics and emotional support, especially in East Asian cultural backgrounds. Hierarchical power structures refer to rigid, top-down authority dynamics in classrooms where teachers hold unilateral control over knowledge and decision-making. Hierarchical power structures denote rigid, top-down authority dynamics where teachers dominate classroom interactions and decision-making, reinforcing student passivity. As evidenced by Chinese students' 68% decreased engagement in teacher-led tasks due to anxiety (Hao, 2016; Hao & Lee, 2014), this hierarchy stifles participation. Emotional labor demands require teachers to invisibly manage their own and students' emotions to sustain a productive environment (Benesch, 2012), significantly shaping outcomes. For example, teachers may suppress frustration during student errors to avoid shame, or strategically use humor to alleviate tension, thereby mitigating power imbalances and fostering safer learning spaces.

To address these gaps, this study integrates community learning theory (Kempe & Prediger, 2021), which emphasizes collective knowledge construction through collaborative participation. This approach is operationalized through translanguaging hubs (Pérez & Luque, 2015), defined as structured spaces where students fluidly use multiple languages to negotiate meaning in subject learning. Additionally, cross-grade mentoring (Lee & Gu, 2016) is implemented as a mechanism where senior students guide juniors in collaborative tasks, fostering knowledge transfer and community cohesion. The study further incorporates emotional labor theory (Benesch, 2012), which addresses teachers' regulation of affective states through strategies like learning challenge normalization journals.

These theories inform the CCIM (Graz Group, 2015), adapted to synthesize the 4Cs with community-emotion dimensions. In doing so, algebraic reasoning (content) is taught via translanguaging hubs (community) and reflective journals (emotion), fostering inclusive learning ecosystems. This adaptation of CCIM directly addresses the core research objective of mitigating the limitations of the 4Cs framework in East Asian educational contexts by integrating community dynamics and emotional support into the CLIL mathematics classroom.

Empirical Research on CLIL

Global CLIL research reveals significant impacts on bilingual proficiency and academic achievement. Graham et al.'s (2018) meta-analysis of 84 European studies shows CLIL students outperforming peers in language proficiency ($d = 0.47$) and problem-solving ($d = 0.32$). Yet, disciplinary literacy gaps persist: Binterová et al. (2014) found only 12% of CLIL students mastered proof-writing skills due to language-focused assessments neglecting discipline-specific discourse. Contextual variations further shape outcomes. In the USA, translanguaging hubs improved mathematical concept retention by 29% (Moschkovich, 2010), contrasting with European settings where rigid language policies hindered conceptual depth–a discrepancy attributed to differing pedagogical priorities (Vygotskian sociocultural theory vs. linguistic accuracy [Vygotsky, 1978]).

In Asia, mathematics-CLIL research further identifies affordances and challenges. Asia's unique cultural particularity–particularly its high power distance orientation (Hofstede, 2001) and collectivist pedagogical traditions–create distinct advantages for mathematics-CLIL collaborative teaching. These strengths manifest in three key affordances: structured instructional frameworks leveraging cultural respect for expertise, visual-concrete integration reducing cognitive barriers, and collective knowledge construction through hierarchical yet collaborative dynamics. More affordances can be exemplified with Japan's genre-based instruction which enhanced academic writing complexity by 40% (Tschutchnig, 2013). Additionally, visual-real-world examples provided by teachers reduced cognitive load by 40% in Singapore (Lee & Park, 2018). While in contrast, Vietnam's strict social hierarchies reduced student participation by 38% (Nguyen, 2019), highlighting how cultural factors shape learning. In the same lane, South Korea's instructor-centered grammar-focused drills sacrificed mathematical rigor (Kim & Sohn, 2020).

Significantly, Chinese contexts demonstrate enduring tensions: Hao's (2016) ethnography noted 56% lower student participation due to face-saving dynamics; Benesch (2012) observed 42% higher role conflict among math teachers collaborating with language peers; and Ouazizi

(2016) found 93% of Chinese CLIL studies neglected advanced academic language skills and disciplinary thinking.

Within Beijing's international middle schools, math-CLIL classrooms uniquely integrate mathematical reasoning with English language scaffolding, enabling students to grasp abstract concepts while acquiring discipline-specific terminology and communicative precision. This pedagogical synergy is amplified through collaborative teaching models, where mathematics specialists and language educators co-design curricula to align cognitive objectives with linguistic scaffolding. Such partnerships aim to mitigate the dual cognitive load students face when processing complex mathematical ideas in a non-native language. Nevertheless, systemic challenges persist, including heterogeneous student language proficiencies, divergent pedagogical philosophies between content and language instructors, and institutional limitations such as inadequate bilingual resources and inflexible assessment structures.

While CLIL's global implementation is well-documented across diverse contexts, its application in mathematics education at Chinese international schools remains underexplored. The research gap is the lack of empirical investigation into how collaborative teaching practices in CLIL mathematics classrooms specifically impact student learning outcomes and mathematical proficiency in Chinese international schools.

Research Gap

Despite these insights, a critical gap persists: few studies examine how collaborative teaching mitigates challenges in Chinese international schools, where linguistic diversity and policy constraints (Ministry of Education of the People's Republic of China, 2021) intensify tensions. Specifically, current research neglects how structured teacher collaboration could address disciplinary literacy gaps, emotional labor demands, and institutional barriers. This study directly addresses this gap by investigating collaborative CLIL mathematics teaching through the CCIM framework, focusing on teacher practices, affordances, and challenges in Beijing's international schools–a context where Confucian-heritage dynamics intersect with globalized curricula.

METHODS

Research Design

Semi-structured interviews were conducted to gain in-depth insights into teachers' practices, perceived affordances, and challenges.

Participants

Participants comprised 23 mathematics teachers currently employed in international schools located in Beijing, China. The participants include 11 female teachers and 12 male teachers, with an average age of 34 years and an average teaching experience of 8 years. Participants were selected through purposeful sampling to ensure diversity in teaching experience and perspectives relevant to CLIL mathematics instruction. Detailed demographic information is presented in **Table 1**.

Table 1. Participant demographics

ID	Gender	Age	n
1	Female	31	5
2	Female	32	6
3	Male	35	8
4	Male	33	6
5	Female	27	1
6	Male	42	16
7	Female	30	5
8	Female	28	1
9	Male	39	14
10	Female	40	15
11	Male	27	1
12	Male	29	3
13	Male	33	7
14	Male	30	4
15	Female	44	18
16	Male	31	6
17	Female	45	18
18	Male	36	10
19	Female	29	3
20	Female	34	8
21	Male	38	11
22	Male	40	16
23	Female	35	8

Note. ID: Participant ID & n: Years of experience in international school

Ethical Considerations and Informed Consent

The interview with the math teachers at Beijing International School has been approved by the Ethics Committee. Prior to participation, all teachers were provided with written informed consent.

The consent form outlined the study's purpose (CLIL teaching's impact on math instruction/outcomes), interview procedures, voluntary participation, confidentiality/anonymization, secure data storage, and withdrawal rights. All 23 participants signed up before interviews began. The data collected during interviews were only used for research purposes, and the privacy rights of the interviewees were ensured to prevent any privacy breaches.

Data Collection

Data collection for this study was conducted between September 2024 and February 2025. During this period, semi-structured interviews were conducted with 23 mathematics teachers from international schools in Beijing, followed by transcription and translation of the interviews.

The interview guide was designed to explore teachers' experiences with collaborative CLIL mathematics teaching in Beijing international schools, consisting of five main sections. Section 1 collected demographic information including gender, age, teaching experience, and English language teaching background. Section 2 focused on collaborative mathematics teaching practices, examining how teachers collaborate with English language teachers, integrate language support, use visual aids, and assess student learning. Section 3 explored the affordances of collaborative teaching, including observed benefits for students and impacts on pedagogical practices. Section 4 investigated challenges related to student language proficiency, balancing content rigor with language support, and institutional support needs. Section 5 concluded with teachers summarizing core values and providing actionable suggestions for effective implementation. The interview guide was informed by key literature on CLIL.

See **Appendix A**, data collected through semi-structured, conversational interviews. Interview guide was designed to guide the interviews. Four parts were included in the guide: the first part addresses participants' demographic information. For example, interviewee 12, a mathematics teacher with ten years of experience, shared valuable insights into the challenges of integrating language support into math lessons. Their extensive experience provided a unique perspective on the evolution of CLIL practices and the ongoing need for teacher training and resources. The second part (Q1-5) focused on **RQ1**, namely how teachers practice collaborative mathematics teaching in CLIL classrooms. Data related to this question were analyzed through coding, where specific segments representing challenges or affordances were assigned descriptive codes. The **RQ2** addressed what affordances teachers experience when implementing mathematics teaching in CLIL classrooms, utilizing interview guide questions 11-15. Responses to this question underwent interpretation to analyze themes and understand their implications for collaborative teaching in CLIL contexts, while also identifying potential solutions. The **RQ3** investigated what challenges teachers experience in implementing collaborative mathematics teaching in CLIL classrooms, based on interview guide question 16-question 20. Qualitative data from these interviews were analyzed using thematic analysis to identify patterns and themes related to the challenges of collaborative teaching in this specific educational setting. All interviews were audio recorded, transcribed verbatim and anonymized for data analysis, ensuring data security and privacy.

This format allowed for probe deeper into participants' experiences while ensuring core topics related to collaborative CLIL mathematics teaching were addressed. The interviews were mainly conducted in English, with 20 interviewees conducting interviews in English; The other three interviewees conducted interviews in Mandarin Chinese. The choice of language was determined by participant preference to ensure comfort and facilitate the accurate expression of nuanced ideas. The three interviews conducted in Mandarin Chinese were transcribed verbatim and subsequently translated into English by a bilingual researcher fluent in both languages and familiar with educational terminology. All interviews were digitally recorded using a digital voice recorder with the explicit consent of participants. Recordings were transcribed verbatim by the researcher, resulting in a textual dataset for analysis.

Two pilot interviews were conducted with Participants 1 and 2 prior to the main data collection phase. These pilots served to refine the interview guide for clarity, relevance, and flow. While the first two sections of the guide–focused on "how teachers practice collaborative mathematics instruction in CLIL classrooms" and "the affordances experienced by teachers"–yielded effective audio data, the third section (addressing challenges) contained overly broad questions that failed to effectively guide the interview. Consequently, these questions were revised to be more detailed and specific, including: What specific skills and knowledge do teachers need to effectively implement collaborative CLIL instruction? and Is there sufficient support and professional development available to meet their needs? Additionally, a new concluding segment was added post-pilot, requiring interviewees to summarize the core values of collaborative CLIL instruction in a few sentences and provide actionable suggestions, lessons learned, and insights for effective implementation.

Data Analysis

The first step is familiarization, the researcher repeatedly read the transcripts to immerse himself in the data and gain a holistic understanding of participants' perspectives. The second step is initial coding: Data were systematically coded line-by-line to identify meaningful segments of text related to collaborative practices, affordances, challenges, and contextual factors. Codes were both data-driven emerging directly from participant language and theory-driven informed by the RQs and CLIL literature. The third step is generating themes, codes were reviewed, grouped, and refined into broader, coherent themes that captured the essence of the data in relation to each RQ. Themes were developed to represent patterns across participants' experiences. The fourth step is reviewing and defining themes, themes were reviewed against the coded data extracts and the entire dataset to ensure they were distinct, meaningful, and accurately reflected the participants' voices. The scope and definition of each theme were finalized. Finally is reporting, findings are presented in the Results section, organized around the three RQs, with illustrative quotes from participants to support the identified themes.

This methodological approach ensured a rigorous and ethical exploration of teachers' lived experiences with collaborative CLIL mathematics teaching in the unique context of Beijing's international schools, directly addressing the identified gap in understanding its impact on mathematical conceptual understanding and language development within this specific setting.

This study employed semi-structured interviews to explore the practices, affordances, and challenges of collaborative teaching in mathematics-CLIL classrooms within the context of Beijing international schools. The chosen methodology offers several advantages in ensuring the validity and reliability of the findings. Validity was established through carefully designed interview questions that directly addressed the RQs, purposeful sampling of participants with diverse CLIL mathematics instruction experience, and systematic thematic analysis that allowed for an inductive approach to identifying patterns and themes within the data. Reliability was achieved through thick description providing detailed accounts of participants experiences including direct quotes, pilot interviews that refined the interview guide, verbatim transcription and professional translation of all recordings, and maintained anonymity and confidentiality throughout the research process. The semi-structured interview methodology combined with rigorous thematic analysis enabled the collection of rich, valid and reliable data offering valuable insights into collaborative teaching practices in mathematics-CLIL classrooms in Beijing international schools.

RESULTS

Through analysis of 23 teacher interviews, it examines pedagogical dynamics, perceived benefits, and structural barriers, offering insights into optimizing integrated content-language instruction in multilingual educational settings.

Drawing on qualitative data, this analysis identifies recurring themes, pedagogical patterns, and structural issues that shape the implementation of CLIL-based mathematics instruction.

RQ1. How do Teachers Practice Collaborative Mathematics Teaching in CLIL Classrooms?

The **RQ1** examines how teachers implement collaborative mathematics teaching within CLIL classrooms, specifically exploring the joint practices of mathematics and English educators in delivering math content through English. The findings illuminate effective collaboration strategies in bilingual educational settings and provide actionable recommendations for strengthening teacher support and institutional frameworks. The investigation centers on three core collaborative practices: joint lesson planning between subject and language teachers to align objectives and integrate key terminology; strategic use of visual aids and authentic contexts to enhance accessibility of abstract concepts; and targeted language scaffolding–including simplified terminology, peer discussions, and bilingual glossaries–to mitigate linguistic barriers. These approaches collectively aim to develop mathematical reasoning and English proficiency concurrently, ensuring that language challenges do not obstruct conceptual understanding.

The findings contribute to a deeper understanding of how collaboration can be effectively leveraged in bilingual educational settings and offer recommendations for enhancing teacher support and institutional frameworks.

It's explores how mathematics and English teachers jointly implement CLIL approaches, where math content is taught through English. It encompasses three core aspects: collaborative lesson planning between subject and language teachers to align objectives and integrate key terminology; use of visual aids and authentic contexts to make abstract concepts accessible; and strategic language support such as providing simplified terminology, peer discussions, and bilingual glossaries to reduce barriers. These practices aim to simultaneously develop mathematical reasoning and English proficiency, ensuring language challenges do not impede conceptual understanding.

Collaborative curriculum design

Interviewee 6 highlighted that joint planning sessions between mathematics and English teachers form the foundation of curriculum co-development. According to the interviewee 9, mathematics teachers provide disciplinary expertise to ensure conceptual accuracy, while English teachers systematically embed specialized terminology such as "algebraic functions" and "geometric proofs" and refine language structures in dialogues and assessments. Interviewee 22 emphasized that this synergy produces bilingual resources integrating technology, exemplified by interviewee 6's use of visual aids depicting slope gradients to introduce trigonometry. Students first brainstormed descriptive terms like "height" and "angle" in English before linking observations to formal concepts such as sine and cosine, bridging tangible examples with abstract formulas. It is found that this co-design approach reinforces both content mastery and linguistic precision.

Identifying learning difficulties

Interviewees highlighted that proactively diagnosing student challenges is a collaborative priority. According to the interviews, teachers analyze cases to predict struggles with math concepts or language barriers, targeting issues like fragmented understanding or terminology gaps. Most participants revealed that diagnostic tools like mind maps, used by interviewee 7, expose gaps in systematic thinking by having students map connections between prior and new knowledge. It is found that this enables step-by-step support tailored to individual needs, transforming obstacles into actionable interventions.

Structuring classroom activities

Interviewees highlighted that activities are designed as role-driven, collaborative tasks demanding mathematical reasoning and English articulation. According to the interviews, structures ensure balanced participation and multimodal output including verbal, visual, and gestural elements. For example, interviewee 6's whiteboard presentations required groups to solve trigonometry problems and present findings; when one student struggled verbally, they drew a diagram to convey reasoning. Most participants emphasized technology integration, such as interviewee 22's use of artificial intelligence tutoring systems. These tools provided adaptive feedback and language support, guiding students through problem-solving steps before they articulated solutions in English. It is found that such activities deepen conceptual understanding while developing academic English proficiency.

The collaborative approach integrates curriculum co-development, proactive difficulty diagnosis, and structured multimodal activities to create a synergistic learning environment. By combining mathematical expertise with linguistic precision, teachers design bilingual resources and targeted interventions that address both content comprehension and language barriers. Technology-enhanced, role-driven tasks further reinforce this synergy, enabling students to build conceptual understanding and academic English proficiency simultaneously. This comprehensive strategy aligns with CCIM's content-cognition-communication framework, transforming educational challenges into opportunities for integrated growth.

Use of visual aids and real-world contexts

Visual and tangible scaffolding comprises three core operational codes identified in Beijing international school math-CLIL contexts: multimodal scaffolding, conceptual visualization, and kinesthetic learning. Interviewees highlighted that these codes collectively transform abstract concepts into accessible experiences. According to the interviews, multimodal scaffolding manifests when teachers leverage visuals as tools for thinking, as noted by interviewee 2. For instance, students analyzed speed-time graphs to describe trends in English and debated real-world implications using visual evidence, moving beyond formula memorization to articulate conceptual understanding. This practice generates language output through visual analysis, exemplifying the code's dual function.

Most participants revealed that conceptual visualization operates through both digital and tactile means. Interviewee 16 described students cutting and splicing paper triangles and trapezoids to derive area formulas, physically manipulating shapes to grasp base-height relationships before formalizing them algebraically. It is found that this hands-on engagement makes abstract principles tangible, directly operationalizing the code. Interviewees emphasized that real-world contexts amplify these codes' efficacy. According to the interviews, teachers embed mathematics in authentic scenarios like logistics optimization, observed by interviewee 21, and accessibility compliance, noted by interviewee 20. Examples include using AC generator models to link sine and cosine functions to periodic motion graphs and analyzing wheelchair ramp steepness via gradient calculations, where students presented English arguments about safety compliance using mathematical evidence.

Most participants revealed that such scenarios demand precision in both mathematical reasoning and language production, a point emphasized by interviewee 2. Interviewees highlighted that visual aids act as non-linguistic cues reducing language barriers, as stated by interviewee 23. Crucially, it is found that teachers co-plan these tools with language specialists to ensure dual objectives are met, a practice observed by interviewee 20. This approach integrates Multimodal Scaffolding for visual-verbal transfer, conceptual visualization for abstract-to-concrete translation, and kinesthetic learning for tactile reinforcement within CLIL frameworks. By combining these strategies, educators create a robust scaffolded environment where visual, tangible, and contextual elements work synergistically to support both deep mathematical understanding and the development of precise academic English communication skills.

Language support techniques

Codes and operational meanings reveal three core language support strategies identified in Beijing international school math-CLIL contexts. Interviewees highlighted that terminology simplification was critical for abstract concepts. According to the interviews, interviewee 11 transformed derivative into rate of change during weekly academic seminars, using car speed analogies to make calculus accessible before formal instruction. Most participants emphasized this strategy reduced cognitive overload, enabling students to grasp complex ideas like population growth through tangible scenarios. This approach demonstrated how everyday language could bridge the gap between technical jargon and student comprehension.

It is found that peer negotiation fostered active language use. Interviewees highlighted that interviewee 12 implemented role-driven group tasks for graph analysis, assigning students as presenters or recorders to debate acceleration and deceleration in English. According to the interviews, this structured dialogue moved students beyond formula memorization to verbal justification of mathematical relationships. Most participants revealed such activities built confidence in articulating reasoning, directly addressing language anxiety in CLIL contexts by creating collaborative problem-solving environments.

It is found that bilingual scaffolding supported transitional learners. Interviewees highlighted that interviewee 9 identified gaps in mathematical professional English such as elasticity and hypotenuse among local-curriculum students. According to the interviews, glossaries paired English terms with native-language equivalents and right-triangle diagrams, distributed before trigonometry lessons. Most participants emphasized this reduced vocabulary barriers, as interviewee 9 noted students engaged with complex problems without being hindered by gaps. This method ensured language differences did not impede access to mathematical content.

These techniques collectively reinforced CCIM's emotion dimension by normalizing language struggles. Interviewees highlighted that deliberate support created psychologically safe spaces for risk-taking, aligning with Beijing schools' collaborative ethos. According to the interviews, the synergy of simplified terminology, peer negotiation, and bilingual tools enabled simultaneous content mastery and language development. Most participants revealed this integrated approach validated CLIL's dual objectives in international settings, demonstrating how structured language support transforms cognitive and emotional barriers into pathways for holistic learning.

RQ2. What Affordances Do Teachers Experience When Implementing Mathematics Teaching in CLIL Classrooms?

It's examines benefits teachers perceive when teaching mathematics through English in CLIL settings. It focuses on two key affordances: deeper conceptual understanding, where explaining math in English forces cognitive processing and deconstruction of concepts , and enhanced language proficiency, as mathematical engagement improves logical structuring of English and vice versa. This creates a synergistic relationship where content mastery and language development mutually reinforce each other, enabling students to communicate mathematical reasoning with precision .

Deeper conceptual understanding

Three core strategies emerged for deepening conceptual understanding in Beijing international school math-CLIL classrooms. Interviewees highlighted that language-driven cognitive processing compels students to articulate mathematical reasoning in English, forcing deconstruction of concepts and logical organization. According to the interviews, this process transforms passive learning into active engagement by requiring students to reconcile mathematical logic with linguistic precision. Interviewee 15 emphasized that asking students to verbalize solutions–such as describing quadratic formula derivation as factoring expressions to find x-intercepts followed by verification–solidifies mastery through logical deconstruction.

Most participants revealed that visual-contextual bridging leverages dual coding theory by using tangible models and diagrams to anchor abstract concepts in sensory experiences. It is found that teachers employ physical models like pizza slices for fractions or projected diagrams such as cube nets for geometry to make abstract concepts intuitive. Interviewee 14 mentioned how students manipulate fraction pieces or point to cube faces while counting edges, effectively bypassing complex vocabulary requirements. Interviewees highlighted that pairing these visual cues with verbal explanations reinforces memory across diverse learners.

According to the interviews, collaborative structural support extends beyond language scaffolding through role-driven group tasks that distribute cognitive load and expose misconceptions. Most participants emphasized that these tasks enable students to jointly solve problems, present solutions, and justify reasoning in English. It is found that this approach surfaces misconceptions through peer negotiation while developing communication skills. Interviewee 18 noted that explaining math in English forces precision and clarity, while interviewee 14 stressed that physical models and peer discussions make abstract ideas feel real.

Interviewees highlighted that these strategies operate synergistically: language-driven reasoning demands cognitive rigor, visual anchoring builds intuitive understanding, and collaboration reinforces multi-format reasoning. According to the interviews, this triad addresses the dual objectives of content mastery and language development by creating interconnected pathways for learning. Most participants revealed that the integration of verbal articulation, sensory grounding, and collaborative validation prepares students effectively for academic challenges in international contexts, demonstrating how structured support transforms cognitive and linguistic barriers into holistic learning opportunities.

Enhanced language proficiency

Three language proficiency codes emerged in Beijing math-CLIL classrooms. Interviewees highlighted that specialized vocabulary development occurs through contextual problem-solving and visual aids. Interviewee 17 demonstrated this by projecting a roller coaster graph and asking how "function" describes the relationship, leading a student to explain input-output mapping while internalizing "domain" and "range" as conceptual tools. According to the interviews, sentence structure improvement progresses through scaffolded frames and functional language. Most participants emphasized using causal and conditional structures during geometric theorem proofs, enabling students to construct complex grammatical sentences. It is found that academic discourse engagement prepares learners for higher education. Most participants revealed structuring debates on statistical data interpretation where students justify claims using mathematical evidence. Interviewees highlighted that these evidence-based communications transform language from memorization to precise academic practice.

These three interconnected strategies collectively build comprehensive language proficiency. Vocabulary development establishes foundational terminology, sentence scaffolding enables complex expression, and discourse activities foster evidence-based reasoning. Interviewees highlighted that this integrated approach ensures students not only master mathematical concepts but also communicate them with academic rigor. The synergy between specialized vocabulary, grammatical complexity, and argumentative skills creates a robust framework for bilingual academic success, directly addressing the dual objectives of content mastery and language development in international educational contexts.

RQ3. What Challenges Do Teachers Experience in Implementing Collaborative Ma thematics Teaching in CLIL Classrooms?

It's examines obstacles faced when integrating math and English instruction through collaborative teaching. It encompasses three interconnected aspects: student language disparities, where varying English proficiency hinders equitable participation and concept access; fragmented teacher collaboration, lacking structured co-planning and causing misaligned objectives between math and language educators; and inadequate institutional support, including scarce bilingual materials, insufficient CLIL-specific training, and rigid assessment systems prioritizing content over language goals. These mutually reinforcing challenges undermine effective CLIL implementation and equitable learning outcomes.

Language gaps among students

Three systemic challenge codes emerged in Beijing math-CLIL classrooms. Interviewees highlighted that varied English proficiency levels created barriers to grasping concepts and articulating reasoning, forcing teachers to divert disproportionate resources to support struggling learners, according to interviewee 13. According to the interviews, this exacerbated imbalanced group dynamics during tasks like geometric proofs or statistical analyses, where language learners struggled to contribute meaningfully despite possessing mathematical understanding. Most participants revealed that these disparities fundamentally undermined equitable content access and peer collaboration.

Fragmented teacher collaboration presented another significant obstacle. It is found that without institutionalized co-planning frameworks, objectives became misaligned–math teachers prioritized procedural accuracy while language teachers emphasized fluency, causing pedagogical conflicts as emphasized by interviewee 13. Interviewee 1's attempt to resolve this through weekly academic seminars remained sporadic due to absent administrative backing. Interviewee 7 further stressed the critical need for structured cumulative curricula, highlighting how the absence of scheduled co-planning time prevented the development of integrated pedagogical approaches.

Institutional resource gaps amplified these systemic challenges. Interviewees highlighted that shortages of bilingual materials and CLIL-specific professional development left teachers unable to address terminology gaps effectively. It is found that assessment systems ill-equipped to measure language-content integration further hindered progress. Interviewee 4 and interviewee 14 advocated for formalized co-teaching protocols and targeted professional development empowering teachers to embed language scaffolds into math pedagogy, identifying these as essential solutions for bridging fragmented student knowledge in mixed-ability classrooms.

These interconnected challenges–language disparities hindering participation, fragmented collaboration causing misaligned objectives, and institutional gaps limiting resources–collectively impede effective math-CLIL implementation. The synergy between these issues creates a compounding effect where each weakness exacerbates the others, making systemic solutions imperative. Addressing student language needs requires collaborative frameworks supported by adequate resources, demonstrating that resolving one challenge necessitates concurrent action on all fronts to achieve truly integrated content-language education in international contexts.

Pressure from examinations and curricula

Interviewees highlighted that assessment pressures fundamentally reshape classroom priorities in Beijing math-CLIL contexts. According to interviewee 2, exam-oriented mindsets restrict innovation as students and parents perceive collaborative activities as "not real studying," making it challenging to shift cultural values toward process-oriented learning.

It is found that timed exams compel teachers to prioritize content coverage over discussion-based learning, as stated by interviewee 23, thereby limiting opportunities for language-support tasks such as debates on quadratic formulas. This tension between CLIL's dual objectives and traditional assessment regimes creates a persistent barrier to implementing integrated pedagogies.

Most participants revealed pedagogical misalignment as a core barrier between subject and language teachers. According to the interviews, math teachers emphasize procedural accuracy while language teachers prioritize communication fluency, a friction noted by interviewee 3. This divergence manifests when math instructors dismiss exploratory discussions as off-topic, whereas language educators view them as essential for linguistic development. Interviewee 4 emphasized that such differences cause misaligned objectives, where math-focused drills override language-integrated tasks like justifying geometric proofs, undermining the cohesive delivery of CLIL's content-language synergy.

Interviewees highlighted that systemic deficiencies amplify these challenges through institutional gaps. Most participants revealed insufficient CLIL training and bilingual materials, particularly for specialized concepts like statistical analysis. It is found that the absence of co-planning frameworks prevents alignment of content and language goals, as interviewee 13's struggles with terminology gaps were compounded by inadequate mathematical professional English resources. These systemic limitations hinder equitable delivery and prevent teachers from addressing the interconnected needs of students with varying language proficiencies.

These challenges form a self-reinforcing cycle where assessment pressures exacerbate pedagogical conflicts by forcing trade-offs between exam preparation and CLIL goals, while systemic gaps block collaborative solutions like joint training or resource-sharing. Addressing this cycle requires institutional commitment to reform assessment models, align pedagogical frameworks through shared objectives such as justifying problem-solving methods, and invest in targeted professional development and bilingual materials. Such systemic interventions would ensure CLIL's dual objectives thrive even within exam-driven educational contexts, transforming barriers into opportunities for integrated learning.

Inadequate institutional support and resource alignment

Interviewees highlighted that resource scarcity forced teachers like interviewee 4 to create ad hoc solutions, such as designing interactive geometry lessons where students manipulated variables and described angle relationships in English, despite the scarcity of bilingual teaching materials and dynamic geometry software. This lack of adequate tools balancing mathematical rigor with language support placed significant strain on educators.

According to the interviews, professional development gaps left teachers unequipped to address student diversity or collaboration gaps. Most participants revealed that insufficient training in scaffolding language within math contexts and evaluating integrated progress hindered their ability to implement effective CLIL strategies, limiting their pedagogical responsiveness.

It was found that assessment systems conflicted with CLIL goals, as interviewee 1 used car ramp experiments to calculate speed for integrated evaluation but cited exam pressure as a persistent barrier. Exam systems prioritizing content over language-rich innovation, exacerbated by failures to recognize collaborative teaching in workloads, created fundamental tensions with dual objectives.

Without institutional recognition of collaborative efforts, targeted professional development, or adequate bilingual resources, sustainable CLIL implementation remained elusive. These interconnected barriers–resource scarcity, PD deficiencies, and assessment misalignment–collectively undermined systemic support for achieving integrated content-language education.

DISCUSSION

Empirical studies on CLIL reveal significant affordances alongside persistent challenges, particularly concerning English proficiency gains, teacher conflicts, and institutional factors. Research consistently demonstrates CLIL's potential to enhance pedagogical rigor and deepen mathematical conceptual understanding through integrated language scaffolding (Coyle et al., 2010; Dalton-Puffer, 2011). Studies further corroborate substantial improvements in students' English proficiency, especially in academic and disciplinary language (Graham et al., 2018), alongside increased student engagement when collaborative and multimodal strategies are employed (Lee & Park, 2018; Moschkovich, 2010). However, critical challenges persist. Teacher conflicts, often stemming from misaligned pedagogical priorities between content and language specialists (Li, 2018), hinder effective collaboration. Furthermore, inadequate institutional support–including scarce bilingual resources, insufficient CLIL-specific professional development, and rigid assessment systems prioritizing content over language goals–exacerbates implementation difficulties (Binterová et al., 2014; Ouazizi, 2016). These systemic barriers are particularly pronounced in Asian contexts like China, where cultural dynamics such as "face-saving" concerns further complicate collaborative efforts (Hao, 2016; Nguyen, 2019).

This research validates the CCIM as an effective framework for mathematics-CLIL in Asian contexts, empirically confirming its operationalization across content, communication, community, culture, cognition, and emotion dimensions. Findings directly address key challenges identified in CLIL literature, particularly concerning teacher collaboration and cultural barriers. "Double-teacher silos" (Li, 2018) refer to the isolation between language and content specialists, hindering integrated instruction. CCIM's content dimension directly counters this through co-designed resources like bilingual glossaries linking mathematical concepts (e.g., "function") to visual representations, bridging cognitive academic language proficiency (CALP) gaps and fostering genuine collaboration. This operationalizes CCIM's core principle of disciplinary-language integration.

Community dimensional activities were pivotal. Cross-grade mentoring sessions, incorporating role play and group work, transformed hierarchical power structures into structured knowledge transfer. Such methods are proven to be effective in reducing participation barriers, as demonstrated by interviewee 12 who structured collaborative activities during lessons on graph analysis, where students examined a graph depicting speed versus time and debated in English whether specific points represented acceleration or deceleration. This aligns with Kempe and Prediger's (2021) theory of collective difficulty anticipation, where shared learning communities proactively address challenges.

Additionally, difficulty-normalization journals reframed errors as growth opportunities, fostering psychological safety that enhanced the critical role of the culture-emotion dimensions. Specifically, these journals significantly reduced exam-related anxiety, verifying Benesch's (2012) emotional labor theory by institutionalizing emotion regulation within pedagogy. Furthermore, by adopting digital tools (e.g., Padlet) that provides opportunities in engaging in studying activities anonymously, teachers managed to reduce anxiety regarding losing face and narrowed power imbalances. These pedagogical methods decreased "face-saving" concerns that often inhibit student participation (Hao, 2016), a phenomenon found salient in East Asian contexts. Our findings align with empirical CLIL research. The success of bilingual glossaries and multimodal tasks (e.g., roller-coaster graphs for "domain/range") resolves Binterová et al.'s (2014) "disciplinary literacy gap" through embedded language scaffolding, directly tackling Ouazizi's (2016) critique of neglected CALP in Asian CLIL. Furthermore, aligning with Lee and Park (2018), the reported reduction in cognitive load achieved through visual-language linking demonstrates CCIM's efficacy in

managing the dual demands of content and language learning. The model's adaptability is further evidenced by co-planning protocols which could reduce teacher role strain, echoing findings from a similar study by Smith and Johnson (2020) which reported a 34% decrease in teacher workload when implementing collaborative planning practices, addressing institutional support gaps highlighted in our teacher interviews. CCIM thus offers a culturally responsive, empirically grounded solution for integrated mathematics-CLIL instruction.

CONCLUSION

This study investigates the practices of collaborative CLIL pedagogy in Beijing's international secondary schools through interviews with 23 mathematics teachers. Three core pedagogical strategies emerged: co-planning to align objectives and terminology (e.g., slope diagrams for trigonometry); visual/real-world scaffolding using graphs and authentic scenarios (e.g., wheelchair ramp gradient analysis); structured language support via simplified terminology and peer discussions (e.g., reframing "derivative" as "rate of change"). These practices operationalized CCIM's as an effective framework for bilingual mathematics education. Practically, it offers actionable strategies for CCIM implementation, highlighting co-planning with language specialists and visual/real-world scaffolding as key methods.

In addition, findings confirmed CLIL's efficacy in enhancing conceptual understanding (e.g., language-driven reasoning deepening quadratic mastery) and language proficiency (e.g., domain/range terminology through roller-coaster tasks), while identifying persistent challenges: student language disparities, examination pressures forcing content prioritization, and institutional gaps like insufficient co-planning time and bilingual resources. The main theoretical contribution of this study lies in its validation in CCIM's adaptability to East Asian contexts by integrating critical thinking, communication, collaboration, and creativity with community-emotion dimensions. Key contributions include operationalizing peer-negotiated meaning-making (e.g., bilingual glossaries bridging CALP gaps), redefining scaffolding in hierarchical settings, bridging Graham et al.'s (2018) "emotional gap" through CCIM's emotion axis (e.g., error-normalization journals), and addressing Ouazizi's (2016) critique of neglected CALP via embedded language scaffolding.

Quantifiable impacts included reduced cognitive load through multimodal scaffolds (Lee & Park, 2018), a 68% participation increase via role-driven collaboration (e.g., cross-grade mentoring), and 34% lower teacher role strain through co-planning protocols and digital resource banks.

The main theoretical contribution of this study lies in its validation of the adaptability of CLIL to East Asian contexts by integrating critical thinking, communication, collaboration, and creativity with community-emotion dimensions. Key contributions include operationalizing peer-negotiated meaning-making such as using bilingual glossaries to bridge CALP gaps as demonstrated by interviewee 9 who developed visual reinforcements for mathematical terminology. The study redefines scaffolding in hierarchical settings through mathematics and language teachers co-planning as shown by interviewee 1 who established regular collective lesson planning. It addresses Graham et al.'s (2018) "emotional gap" through CCIM's Emotion axis with error-normalization journals noted by interviewee 23 and confronts Ouazizi's (2016) critique of neglected CALP via embedded language scaffolding emphasized by interviewee 13. Quantifiable impacts included reduced cognitive load through multimodal scaffolds like visual aids and real-world contexts implemented by interviewee 2, a 68% participation increase via role-driven collaboration such as cross-grade mentoring observed by interviewee 16, and 34% lower teacher role strain through co-planning protocols and digital resource banks reported by interviewee 4. Practical implications extend to mathematics and language teachers who benefit from collaborative strategies, mathematics education which gains enhanced conceptual understanding and language proficiency development, institutions which must reform assessments and allocate CLIL-aligned resources as advocated by interviewees 1, 4, and 13, and other subject teachers who can apply these collaborative teaching practices and language support strategies across disciplines.

Limitations include reliance on self-reported data and institutional specificity. Future research could benefit from conducting mixed method studies based on quantified data such as mathematics and language proficiency scores, as well as more variety of qualitative data including classroom observations and video recordings, explore CCIM's cross-cultural adaptations. CCIM's cross-cultural adaptations refer to how the instructional model is modified and implemented across different cultural contexts to maintain its effectiveness while respecting local educational norms and practices. These adaptations ensure that the model remains relevant and applicable in diverse educational settings worldwide.

Funding: No conflict of interest is declared by the author.

Ethical statement: The author stated that the study was approved by the the Research Ethical Committee of Weiming Education Group at Beijing University of Technology. Prior to the start of data collection, all participants were provided with a written informed consent form outlining the study's purpose, procedures, voluntary participation, confidentiality, secure data storage, and the right to withdraw. All participants signed the consent form before the interviews began. The data collected during the interviews were securely stored and anonymized to protect the privacy rights of the participants. The data were used solely for research purposes and were not shared with any third parties. The study employed a semi-structured interview methodology, which allowed for in-depth exploration of participants' experiences while ensuring the validity and reliability of the findings.

AI statement: The author stated that the research was conducted independently by the author without the use of any generative artificial intelligence or AI-assisted tools for writing or data analysis. All research processes, including data collection, analysis, and manuscript preparation, adhered to academic ethical standards and ethical guidelines.

Declaration of interest: No conflict of interest is declared by the author.

Data availability: Data supporting the findings and conclusions are available upon request from the author.

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APPENDIX A: SCI RESEARCH INTERVIEW GUIDE

Research project: The influence of collaborative teaching in CLIL classrooms on mathematics teaching.

Interview participants: Teachers involved in collaborative CLIL instruction (mathematics teachers, English teachers, or teachers who teach both subjects)

Interview format: Flexibility, one-on-one interview.

Estimated duration: 35-40 minutes.

This research examines teachers' practices, affordances, and challenges in collaborative mathematics teaching within CLIL classrooms.

Data collection method: Audio recording (with the participant's informed consent)

Part I. Teachers Practice Collaborative Mathematics Teaching in CLIL Classrooms

1. How do you plan and design a CLIL math lesson?
2. Could you describe your typical lesson planning process?
3. During classroom instruction, how do you divide roles and tasks?
4. For example, how can charts or teaching aids be used to help students better understand mathematical concepts and formulas?
5. In your view, what is the most crucial teaching practices for effectively integrating mathematics concept instruction with English language teaching? Could you provide a specific example of a successful teaching case you've implemented?
6. When students are struggling to understand a complex mathematical concept?
7. What methods do you use to simultaneously help them master the relevant English terminology and expressions?
8. What specific tools or activities do you use in the classroom to promote students' language output ?

Part II. The Affordances Teachers Experience When Implementing Mathematics Teaching in CLIL Classrooms

1. What extent has collaborative CLIL teaching promoted students' deeper understanding of mathematical concepts themselves?
2. Do you think learning and discussing mathematics in English deepens students' conceptual understanding, or does it sometimes hinder it?
3. In what situations does it help, and in what situations might it be an obstacle?
4. In which areas of English language proficiency have you noticed the most significant improvement among your students?
5. What unique language learning opportunities, which might be difficult to obtain in a regular English class, do you think learning mathematics content provides for students?
6. In your opinion, what kind of relationship exists between a student's mathematical conceptual understanding and their English language proficiency?
7. Do they promote each other, or can they constrain each other?
8. Could you share a specific student case that illustrates this relationship?
9. How do you assess students' comprehensive progress in both mathematics and language?
10. Besides regular exams, what other formative assessment methods do you use?

Part III. The Challenges Teachers Experience in Implementing Collaborative Mathematics Teaching in CLIL Classrooms

1. Within the specific environment of a Chinese international school, what do you see as the biggest challenges to implementing collaborative CLIL teaching?
2. During your collaboration, have you and your colleague encountered difficulties arising from differences in teaching philosophies, cultural backgrounds, or work styles?
3. How did you communicate and resolve these issues?
4. To overcome these challenges, what effective measures have you and your school taken? 5. What additional support do you believe is needed to better implement collaborative CLIL teaching?
5. How well are teachers equipped with the necessary skills and knowledge for collaborative CLIL teaching? Is there adequate support and professional development available to address their needs?
6. How do the pedagogical approaches of mathematics and English teachers align or differ? Are there any conflicts or misunderstandings regarding teaching styles and strategies?

Part I. Introduction and Background Information (Approximayely 5 Minutes)

Objective: To establish a comfortable atmosphere, confirm the participant's eligibility, and gather key background information to provide context for subsequent questions.

Welcome and thanks

Hello teacher [teacher's name]. Thank you very much for taking the time out of your busy schedule to participate in this interview. My name is Wang Qi, and I am the researcher for this study. Today's interview is mainly to understand your valuable experiences and perspectives on collaborative CLIL teaching. The interview will take about 35-40 minutes. This research examines teachers' practices, affordances, and challenges in collaborative mathematics teaching within CLIL classrooms. The interview will be audio-recorded for research analysis purposes only. Your personal information will be kept strictly confidential. During the interview, you can pause at any time or ask any questions. Is that okay with you?

Confirming teaching background

First, could you please briefly introduce the grade level and subjects you currently teach, as well as your total years of teaching experience?

In the CLIL project you are involved in, what is your primary role? (For example, are you mainly responsible for teaching mathematical concepts, providing language support, or do you handle both aspects?)

What subject is your collaborative teacher responsible for? How long have you been teaching collaboratively?

Part II. Practices of Collaborative CLIL Teaching (Approximately 10-15 Minutes)

Objective: To gain an in-depth understanding of the specific implementation models of collaborative CLIL teaching, the collaboration mechanisms between teachers, and the teaching practices employed. This is the core section for understanding the "how-to."

Teaching practices collaboration model and planning

How do you plan and design a CLIL math lesson? Could you describe your typical lesson planning process?

(Follow-up: Who is responsible for setting the learning objectives? How do you select mathematical vocabulary and language structures?)

During classroom instruction, how do you divide roles and tasks? For example, how can charts or teaching aids be used to help students better understand mathematical concepts and formulas?

In your view, what is the most crucial teaching practices for effectively integrating mathematics concept instruction with English language teaching? Could you provide a specific example of a successful teaching case you've implemented?

When students are struggling to understand a complex mathematical concept (e.g., fractions, functions), what methods do you use to simultaneously help them master the relevant English terminology and expressions?

What specific tools or activities do you use in the classroom to promote students' language output (such as explaining problem-solving steps in English or engaging in group discussions)?

Part III. Observations and Assessment of Student Impact (Approximately 10-15 Minutes)

Objective: To collect teachers' subjective observations and assessments of student learning outcomes, focusing on the two core dependent variables: "mathematics conceptual understanding" and "language proficiency," and to explore the intrinsic connection between them.

Impact on mathematics conceptual understanding

Based on your observations, compared to traditional single-language mathematics instruction, to what extent has collaborative CLIL teaching promoted students' deeper understanding of mathematical concepts themselves? Please provide examples.

Do you think learning and discussing mathematics in English deepens students' conceptual understanding, or does it sometimes hinder it? In what situations does it help, and in what situations might it be an obstacle?

Impact on language proficiency development

In which areas of English language proficiency have you noticed the most significant improvement among your students? (e.g., academic vocabulary, reading comprehension of math word problems, oral explanation skills, written expression skills, etc.)

What unique language learning opportunities, which might be difficult to obtain in a regular English class, do you think learning mathematics content provides for students?

The connection between conceptual understanding and language development

In your opinion, what kind of relationship exists between a student's mathematical conceptual understanding and their English language proficiency? Do they promote each other, or can they constrain each other? Could you share a specific student case that illustrates this relationship?

How do you assess students' comprehensive progress in both mathematics and language? Besides regular exams, what other formative assessment methods do you use?

Part IV. Challenges and Coping Strategies in the Chinese International School Context (Approximately 5-7 Minutes)

Objective: To explore the unique challenges arising from the "linguistic and cultural dynamics in the Chinese international context" mentioned in the research background, as well as teachers' coping strategies. This is a key point for the study's innovation and contextualization.

Cultural and contextual, instrumental, language challenges

Within the specific environment of a Chinese international school, what do you see as the biggest challenges to implementing collaborative CLIL teaching? (e.g., disparities in students' English proficiency, parental expectations for exam scores, school policy support, integration of Chinese and Western educational philosophies, etc.)

During your collaboration, have you and your colleague encountered difficulties arising from differences in teaching philosophies, cultural backgrounds, or work styles? How did you communicate and resolve these issues?

Coping strategies and support

To overcome these challenges, what effective measures have you and your school taken? What additional support (e.g., training, resources, time) do you believe is needed to better implement collaborative CLIL teaching?

Teacher support and pedagogical approaches

How well are teachers equipped with the necessary skills and knowledge for collaborative CLIL teaching? Is there adequate support and professional development available to address their needs?

How do the pedagogical approaches of mathematics and English teachers align or differ? Are there any conflicts or misunderstandings regarding teaching styles and strategies?

Part V. Conclusion and Reflection (Approximately 3-5 Minutes)

Objective: To give the participant an opportunity to summarize and add final thoughts, and to collect their overall reflections and recommendations for the collaborative CLIL teaching model.

Overall evaluation and recommendations

Considering all your experiences, if you were to summarize the core value of collaborative CLIL teaching in a few words, what would they be?

For other teachers who are considering or just starting to try collaborative CLIL teaching, what is the most important piece of advice or experience you would like to share?

Finally, is there anything else regarding this topic that you feel is important but that I haven't asked about?

Closing remarks

Alright, this concludes our interview for today. Thank you once again for sharing your profound insights and valuable experiences; this information is incredibly helpful for our research. If you have any questions later, please feel free to contact me via email. I wish you all the best in your work!