Teacher and Student Perceptions of CLIL in Computer Science: Benefits and Challenges in a Trilingual Context

Percepciones de profesores y alumnos sobre el AICLE en informática: ventajas y retos en un contexto trilingüev

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ABSTRACT. This study examines the perceptions of teachers and students regarding the use of CLIL in the subject of computer science within Kazakhstan's trilingual education context. Utilizing a convergent parallel mixed-methods design, the research aims to identify the benefits and challenges encountered by stakeholders in CLIL classrooms. The study underscores the importance of learning computer science through English as a medium of instruction using CLIL. The findings highlight that both teachers and students value English-medium CLIL for its enhancement of content knowledge over language skills. Additionally, the results indicate the influence of external summative assessments on emphasizing academic language development. Contrary to common literature, the frequently mentioned challenge of resource scarcity in CLIL education is deemed less significant due to collaborative efforts among teachers to develop resources. Examining the practices of flagship schools helped identify effective strategies for addressing challenges in CLIL environments.

Keywords: English-medium CLIL; computer science; trilingual education; perception; benefits; challenges.

RESUMEN. Este estudio investiga las percepciones de profesores y alumnos sobre el uso de CLIL en la asignatura de Informática en el contexto educativo trilingüe de Kazajistán. Mediante un diseño convergente de métodos mixtos paralelos, la investigación tuvo como objetivo identificar las ventajas y los retos a los que se enfrentan las partes interesadas en las aulas CLIL. El estudio subraya la importancia de aprender informática a través del inglés como medio de instrucción utilizando el enfoque CLIL. Los resultados ponen de relieve que tanto los profesores como los estudiantes valoran el CLIL en inglés por su mejora del conocimiento de los contenidos que por las habilidades lingüísticas. Además, los resultados indican la influencia de las evaluaciones sumativas externas en el énfasis en el desarrollo del lenguaje académico. Contrario a lo que se suele decir en la literatura, el reto de la escasez de recursos en la educación CLIL, que se menciona con frecuencia, se considera menos significativo debido a los esfuerzos de colaboración entre los profesores para desarrollar recursos. El examen de las prácticas de las escuelas emblemáticas ayudó a identificar estrategias eficaces para abordar los retos en los entornos CLIL.

Palabras clave: CLIL en inglés; informática; educación trilingüe; percepción; beneficios; retos.

Introduction

Content and language integrated learning (CLIL) has been defined as a "dual-focused educational approach in which an additional language is used for the learning and teaching of both content and language" (Coyle et al., 2010, p. 1). Research emphasizes the critical role of stakeholders' input on the success of CLIL program implementation. Examining the beliefs and perspectives of key stakeholders—teachers and students—provides valuable insights for policymakers, school administrators, educators, and classroom practitioners (McDougald, 2023).

Despite growing interest in teachers' and students' perceptions of CLIL, there is a dearth of studies on perceptions in specific subjects. Roothooft (2019) suggests that different subjects can present unique linguistic and cognitive challenges in an English-medium instruction (EMI) context. Therefore, this study narrows its focus to computer science within a trilingual educational context. While CLIL has been implemented across various subjects, "computer science is regarded [as] one of the subjects best suited for teaching with CLIL, as English is the lingua franca of computing" (Kussaiynkyzy & Dringó-Horváth, 2022, p. 324). The present study seeks to contribute to the global discourse on CLIL by examining the perceptions of teachers and students in Kazakhstani flagship network schools regarding the use of English-medium CLIL in computer science classes. Thus, the study aimed to address the following questions:

1. What benefits do teachers and students perceive in using CLIL for Computer Science education?
2. What challenges do teachers and students encounter in Computer Science CLIL classrooms?

Literature Review

English-Medium CLIL in Computer Science

CLIL is widely adopted as an umbrella term encompassing programs including content-based instruction, immersion, and English Medium

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Instruction (EMI) as variants (Lo, 2020), where students learn content through an additional language (second or foreign). However, simply changing the medium of instruction to another language does not automatically qualify as CLIL. Successful implementations involve all teachers sharing responsibility for language development to varying extents, even when the language focus is very small (Marsh & Frigols Martín, 2013). The primary aim of CLIL is to enhance exposure, authentic use, and interaction in the target language, thereby boosting motivation by making the language essential for academic success (Lo, 2020).

For many practitioners and researchers, CLIL is closely associated with foreign languages, particularly English (Fortanet-Gomez, 2013). Dalton-Puffer (2011) emphasized that while CLIL can be applied to learning any language, "the prevalence of English as CLIL medium is overwhelming" (p. 183). Consequently, for the purposes of this article, CLIL predominantly refers to CEIL, or Content and English Integrated Learning (Dalton-Puffer, 2011).

While CLIL demonstrates potential benefits across various disciplines, its application in fields such as computer science remains underexplored, particularly regarding stakeholders' perceptions. Weise (2013) highlighted the limited interest in bilingual computer science classes, despite a general consensus on the advantages of learning computer science through English (Kussaiynkyzy & Dringó-Horváth, 2022).

Studying computer science in English offers multiple advantages. First, it provides students with greater access to cutting-edge academic resources. Since English is the primary language of academic discourse in this field, students with advanced English skills can access international papers and technical documents more readily, without delays caused by translation. Additionally, computer languages and commands are based on English terms, making it easier for students to grasp subject-specific concepts and gain a deeper understanding of the material. This preparation is particularly valuable for professional careers, where English proficiency is often required in the computer science field (Kussaiynkyzy & Dringó-Horváth, 2022; Weise, 2013).

Perceived Benefits of CLIL

While there is limited research on perceptions specifically related to computer science (Kussaiynkyzy & Dringó-Horváth, 2022; Weise, 2013),

there are multiple studies on perceptions of CLIL in content subjects more broadly. These studies reveal that students are generally highly motivated both intrinsically and instrumentally; however, the emphasis tends to lean toward instrumental motivation—particularly the practical and pragmatic benefits associated with the CLIL approach (Somers & Llinares, 2018). For instance, the study by Mahan and Norheim (2021) with Norwegian students revealed that the primary reason participants chose CLIL programs was their emphasis on future studies or work. Similarly, students in Zanoni's (2021) study conducted in Italy perceived CLIL as having a beneficial educational influence, particularly in terms of preparing them for further studies or future careers in international and multilingual contexts.

Studies also found that both students and teachers believe that students' target languages improved since they studied in a CLIL environment (Chaieberras & Rascón-Moreno, 2018; Lazarević, 2019; Mahan & Norheim, 2021; McDougald et al., 2023; Roiha, 2019; Zanoni, 2021). Especially, speaking fluency, learning formal English, and the development of subject-specific vocabulary were perceived to have improved (Lazarević, 2019; Mahan & Norheim, 2021; Roiha, 2019; Vega & Moscoso, 2019; Zanoni, 2021). Participants also highlighted that CLIL had contributed to their highly positive English language self-confidence (Chaieberras & Rascón-Moreno, 2018; Roiha, 2019). Teachers identified CLIL as an effective teaching method because it improves students' language and content knowledge, while also promoting critical thinking, collaboration, and problem-solving abilities (McDougald et al., 2023).

Perceived Challenges of CLIL

Research in the past decade highlights significant challenges associated with CLIL for both teachers and students. The most prominent issues include language proficiency barriers, high cognitive demands, limited resources, increased workload, and inadequate professional development.

For teachers, the necessity to improve their language skills to teach content effectively in a foreign language is a significant hurdle. Studies have highlighted that teachers often feel their language proficiency is insufficient, impacting their ability to implement CLIL

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successfully (Andrew, 2018; Karabassova, 2020; Lazarević, 2019) and contributing to a lack of self-confidence in English (Lopriore, 2018). Similarly, Morton (2017) noted that teaching in a less familiar language affects teachers' interactive practices, leading to less content being covered, as seen in Karabassova (2018) and the excessive simplification of the content (Zanoni, 2021).

Students also face linguistic challenges, with many reporting difficulties in comprehension and oral production during CLIL lessons (Pladevall-Ballester, 2014). Teachers fear that the content requirements of lessons would be reduced due to students' low language proficiency (Skinnari & Bovellan, 2016). Additionally, teachers indicated challenges such as a limited vocabulary repertoire, translation issues, and insufficient foundational knowledge (Metlí & Akıs, 2022). Students experience problems with vocabulary retention and understanding lessons in English (Zanoni, 2021), contributing to cognitive overload (Mahan & Norheim, 2021).

Teachers often struggle with balancing content and language instruction, frequently prioritizing content objectives over language learning (Karabassova, 2018; McDougald et al., 2023; Skinnari & Bovellan, 2016). This issue is particularly evident among content-oriented teachers (Villabona & Cenoz, 2021), who tend to view themselves primarily as content experts rather than English language teachers.

The scarcity of appropriate teaching materials and resources is another major challenge for CLIL teachers. Often lacking suitable textbooks, teachers are forced to create their own materials (Kordíková & Brestenská, 2020; Lazarević, 2019; McDougald et al., 2023; Mahan & Norheim, 2021). This lack of resources not only increases their workload but also demands additional time for lesson planning and material preparation (Kordíková & Brestenská, 2020; McDougald et al., 2023).

The Research Context

In 2007, Kazakhstan introduced a trilingual language policy to enhance education and human capital (Bedeker et al., 2023). This policy has primarily been applied in the education field through specially designated

schools, including the Nazarbayev Intellectual Schools (NIS) (Karabassova, 2018). The present study was conducted within a network of 21 state-funded elite NIS located in 18 major cities across Kazakhstan. The network was established in 2008 to bring radical changes to Kazakhstan's education system by testing international innovative educational programs and the trilingual educational model, with the aim of disseminating this experience to other schools across the country (Karabassova, 2018). Trilingual education with a focus on CLIL was an integral part of the implementation of the innovative educational program. The Kazakh, Russian, and English languages are taught not only as separate disciplines but also used to study other subjects. The NIS hires international teachers to support the trilingual environment and enhance local teachers' capacity to teach in English (AEO NIS, 2016).

Methods

Research Design

The research reported here is part of a larger project aimed at examining the perceptions and practices of teachers and students in using ICT-supported CLIL in computer science. To achieve a comprehensive understanding of the phenomena through methods triangulation, this study employed a convergent parallel mixed-methods design. Quantitative and qualitative data were collected concurrently, analyzed independently, and then integrated for interpretation (Creswell & Clark, 2017).

Participants

Approval for conducting this research was obtained from the Research Ethics Committee of the first author's institution (reference number: 2023/105) and the NIS chairperson. Permission was then secured from the NIS principals. Prior to data collection, detailed information about the study was provided to participants, and consent forms were obtained from teachers, students, and their parents.

Partially purposeful convenience sampling (Dörnyei, 2007) was used in both the quantitative and qualitative parts of the study. This involved selecting participants who were available and willing to

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participate and met key criteria: (1) computer science teachers from the NIS who teach grades 11 and 12, where English is the medium of instruction, and (2) students in grades 11 and 12 who selected computer science as a profile subject.

The response rate from teachers was relatively low, with only 35 completing the questionnaire. Among these teachers, 3 were international, and the remaining 32 were local. In comparison, 142 students, aged 16 to 18, participated by completing the questionnaire. Additionally, interviews were conducted with 19 teachers and 12 students.

The reported English levels of participants show that students generally outperform teachers, as the majority of students have B2 (49.3%) and C1 (34.5%) levels, according to the CEFR (Common European Framework of Reference), while the majority of teachers' English proficiency is Intermediate (B1, 45.7%) and upper-intermediate (B2, 31.4%).

Instruments and Procedure

Data were collected using questionnaires and semi-structured interviews. The questionnaires, designed based on relevant prior studies, were tailored for teachers and students; respondents rated their agreement on a 5-point Likert scale from "strongly disagree" to "strongly agree". The tool's validity was established through expert and respondent pre-tests. Content validity was confirmed by two professors and a computer science teacher, while a think-aloud protocol involving one teacher and two students from the target population ensured comprehensibility. The survey was piloted with 10 teachers and 15 students, leading to modifications and some item removals.

This study focuses on perceptions of the benefits—7 items for teachers, 6 for students—and challenges—7 items for both—of using CLIL in computer science. Two semi-structured interview protocols for teachers and students were developed and validated by experts. The survey was distributed online via Qualtrics, and interviews were conducted in person at one NIS school and online at others using Google Meet, with data collection occurring from March to May 2023.

Data Analysis

Data analysis included descriptive statistics for summarizing the central tendencies and dispersion of the responses, and the Mann-Whitney U test to identify any significant differences between teachers and students. Non-parametric tests were used for comparisons because the Likert-scale responses in the study were treated as ordinal data. The qualitative data were analyzed using content analysis methods, with both deductive and inductive coding applied. Joint displays were utilized to facilitate the integration of quantitative and qualitative results and to achieve inferential transparency.

Results

Perceived Benefits of CLIL in Computer Science

In the trilingual context of the NIS, CLIL is implemented in computer science using Russian in the lower grades (7-10), regardless of the students' native language, and English in the upper grades (11-12). Given the study's specific focus on learning computer science in English, the survey prominently emphasized this aspect.

The survey shows positive attitudes towards learning computer science through EMI, utilizing CLIL, with 80% of teachers and 85% of students finding it beneficial (Figures 1 and 2). The Mann-Whitney U test indicates no significant difference in their perceptions across various aspects.

The quantitative and qualitative data revealed several perceived advantages of teaching and studying computer science in English using CLIL.

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Figure 1. Teachers' Perceived Benefits of Teaching Computer Science in English (n = 35)

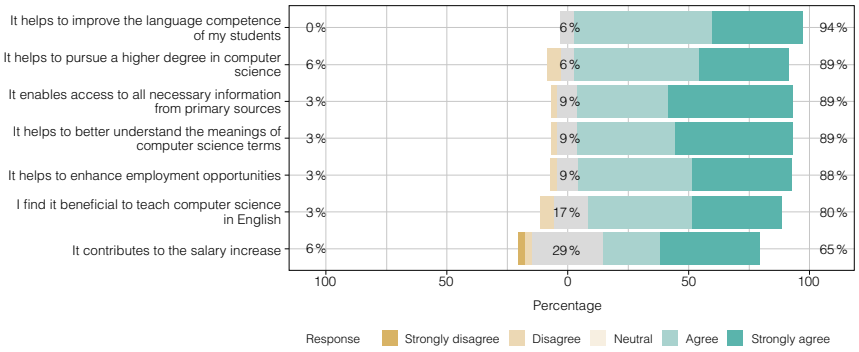
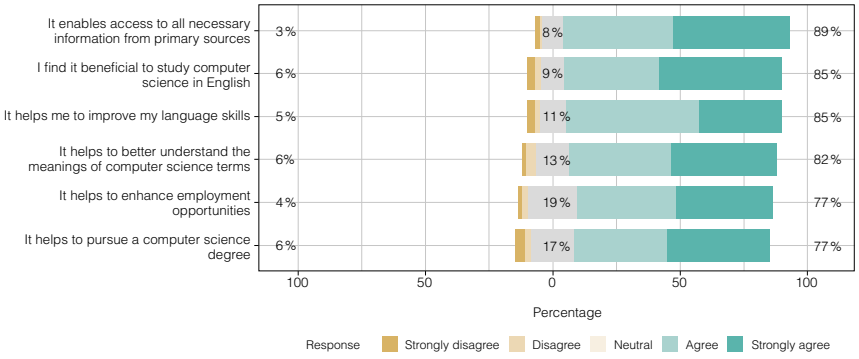


Figure 2. Students' Perceived Benefits of Learning Computer Science in English (n = 142)



Access to a Broader Range of Quality Resources

The survey results showed that teachers and students placed a high value on accessing essential information from primary sources, with 89% of both groups identifying this as a key benefit of trilingual education (Figures 1 and 2). Interview responses further supported this finding, with 63% of teachers and 75% of students emphasizing broader resource access as a major advantage of trilingual education. Respondents expressed a preference for EMI due to the abundance of educational resources and materials available in English. Additionally, participants pointed out the historical roots of computer science in English-speaking countries, indicating that English is the language of origin for many resources

in this field. Furthermore, teachers compared resource access in three languages, noting that the majority of information is in English compared to Russian and Kazakh, and highlighted the limited availability of resources in Kazakh. As one of the teachers stated in the interview:

> Advantages... The primary benefit is resource-wise. For instance, there is a scarcity of resources on computer science in Kazakh. If there are any, they are mostly translations from Russian. However, in Russian, there are resources available, but they are mostly outdated. Whereas in English, for example, there are a lot of textbooks, resources, and online websites. Therefore, it is possible to find very good, high-quality materials on the topic. (T1)

The answers of students also aligned with the responses of teachers. Students expressed a preference for studying in English due to the limited availability of resources in their native language, Kazakh, particularly in computer science:

> I would say that there is almost no information about programming in Kazakh. It is challenging to find. While there is some information in Russian, there is significantly more available in English, including various websites and YouTube channels. Information can be found everywhere, and it is convenient, which makes my studying easier. (S1)

Participants consistently emphasized the higher quality of resources available in English compared to Kazakh and Russian. This sentiment is echoed by both students and teachers, who highlighted the essential role of English in accessing top-notch educational materials. Additionally, teachers emphasized the dynamic nature of computer science, indicating that it is "a rapidly changing field" (T4), and that "keeping up with the latest developments is not possible by learning in Kazakh or Russian alone" (T9), since translation takes time. Students mentioned they used English sources even in lower grades: "English is more common for computer science, and even when we were studying computer science in Russian, we read English resources" (S8).

Better Comprehension of Subject-Specific Terminology

According to questionnaire data, a significant portion of teachers (89%) and students (82%) perceived that studying computer science in English provided another important benefit: a better understanding of the meanings of computer science terms. This benefit was highlighted

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during interviews by ten teachers (53%) and nine students (75%). As teachers noted: "Computer science is one of the few subjects where a lot is borrowed specifically from English-language sources" (T18), making it easier to explain many terms in English (T4). Therefore, "it is preferable to study programming in English for deeper comprehension, and studying the subject in English is essential not only for language development but also for a better understanding of the subject" (T15). T11 added:

> Commands like 'print' and 'reverse' may not be easily understood by non-English speakers, for example. However, if one is familiar with the language, even without knowing how to program, they can grasp the general meaning, understanding what the command does. Since approximately 80% of computer science topics revolve around programming, I believe that studying computer science in English facilitates the learning of these commands.

Students echoed this sentiment, noting that "learning computer science in English is very effective, and many programming languages are in English" (S9). They provided the following examples to reinforce this view: "Many terms in computer science are from the English language, such as 'encapsulation,' 'object,' and 'class'. If you learn those terms in English, they actually make sense compared to learning them in Russian" (S11).

The interview analysis revealed concerns about the limitations of Kazakh language terminology. One teacher highlighted the issue by stating, "There is a lack of accurate Kazakh translations for certain computer science terms" (T3). Another teacher provided further support with the following example:

> For instance, we do not use Kazakh terms such as 'tintwir' for 'mouse,' we rather stick to Russian or English. Some Kazakh terms sound awkward to the ear, and it is possible that not everyone is familiar with them. Some children may not have a clear understanding of terms when heard in Kazakh, so it is clearer for them when the Russian or English equivalents are used. (T4)

Students echoed these concerns, emphasizing the practicality and effectiveness of studying computer science in languages like Russian and, particularly, English. The following excerpt illustrates this:

> The interface language of all devices and settings is in Russian, and all programs are in English. There is typically a scarcity of information available in Kazakh in the field of computer science. That is why it was convenient for me to study it in Russian from 7th to 10th grade. Now, in the 11th grade, I believe that switching to English has an even more positive impact on my learning. (S1)

Future Study and Career Opportunities

The majority of survey participants, including 89% of teachers and 77% of students, agreed with the sentiment that learning computer science in English helps them pursue a higher degree in computer science. Two teachers (10%) and five students (42%) mentioned this advantage during the interview. Studying computer science in English was seen as advantageous for the students' future, as in higher education in Kazakhstan, "top-ranking computer science programs often conduct classes in English and studying computer science in English in school prepares students for this" (T8). Students reinforced this perspective:

> In general, universities teach everything in English. I believe that studying computer science in English now will be very helpful for me in the future. I have been studying it in English for two years and feel confident about it. Developing my skills further should not be a problem. (S5)

Participants also recognized the benefit of enhanced career opportunities. The questionnaire item "It helps to enhance employment opportunities" received significant support, with 88% of teachers and 77% of students agreeing. In interviews, one teacher observed, "If you are developing a product, you need a language that is universally accepted or embraced. Learning in English gives students a competitive advantage over those who learn in Russian or Kazakh" (T10). Similarly, students emphasized the necessity of English in the IT field; one of the students stated: "For coding, programming, or working as a software engineer, knowing English is mandatory" (S3).

Opportunities for Teachers

The survey statement 'It contributes to the salary increase' was exclusively for teachers and emerged as the item with the highest variance in responses. While 65% of teachers agreed with this statement,

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6% expressed disagreement. This statement also elicited the highest proportion of neutral responses, accounting for 29%. The variation in responses is explained by the fact that teaching the subject in English influences salary increases only if teachers achieve a certain level on English proficiency tests. As noted by one teacher, 'In regular schools, teaching in English already results in an addition to salary. However, in our school, we have a set standard' (T14).

Teachers noted that achieving a higher level of English proficiency opens up more opportunities for international training. Several teachers shared that their schools had sent them to countries such as England, Singapore, the USA, and the UAE for professional development courses, while one teacher expressed regret that his application was rejected due to the absence of an IELTS certificate (T15).

Language Development

It is interesting to note that, although a large portion of survey respondents agreed with the statement that CLIL improves students' language competence (94% of teachers and 85% of students), only a few mentioned this advantage during interviews. Teachers believe that having instructions in English can enhance their English proficiency, especially in academic contexts, through increased exposure to the language: "Then once you join the system, we are giving instructions in English, so will your IELTS score improve by that time? I believe so" (T10). Teachers related students' language development to improving subject-specific terms as "learners add new terminology to their vocabulary (T8)".

Students also recognized language benefits from CLIL; one student noted: "Mastering the subjects in English is very helpful. During lessons, you encounter specific new words, understand the structure of sentences, and you can improve your speaking skills. Therefore, I believe that taking classes in English is a good choice" (S5).

Furthermore, the interview responses indicated that preparation for external exams was crucial in developing students' academic knowledge. The exam format required the use of subject-specific terminology, which could significantly influence the final grade. This is evident from the following excerpt:

> Many exam questions state: 'use academic language,' and if there are four points for the right answer, three points are for how well you answered the question, and one point is for using academic language. We often have arguments where students say, 'I wrote everything correctly', but they used simple, colloquial words, showing their academic language level is low, so they get lower marks. (T7)

Students mentioned that initially, they struggled with providing information "comprehensively and correctly" and writing everything "clearly and concisely" (S8) during exam preparation. They developed these skills by seeking guidance from their teachers, who explained the criteria, suggested appropriate terminology, and emphasized the importance of using academic language. External exam questions also require familiarity with various forms of writing and help develop critical writing skills. As T13 noted:

> Some of those exam questions ask for essay-style answers worth six or eight marks. We go over those questions and explain how to answer them. For example, if the question says 'justify' or 'explain,' we clarify what 'justify' and 'explain' mean. If it says 'identify,' we explain what 'identify' means. We look at the keywords in the exam questions, break them down, and then explain what is expected.

Promoting Student-Centered Learning

During the interview participants emphasized that CLIL enhances lesson efficiency by using diverse methods. For instance, one teacher highlighted:

> There are a lot of things that I like in CLIL. When you use CLIL methods, activities, games, you can explain any topic in an easy way. So yes, CLIL is really good, so CLIL really helps to make your lesson efficient. (T16)

Another participant elaborated:

> In order to achieve the goal of the lesson, we use various resources such as hand-out materials, videos, tasks such as filling gaps, matching, hot questions, posing questions to each other, or diverse activities like the hot seat, jigsaw method, carousel, and more. We apply different methods to ensure the lesson's purpose is met. (T1)

It engages students through non-traditional, independent learning approaches, making lessons more interesting and effective: "CLIL is

very interesting for children. This is because the lessons are conducted in a non-standard way. A teacher does not explain in front of the blackboard for 40 minutes, but children work independently" (T1). Initially, lecture-based, teachers have shifted to group work and active learning methods after CLIL training (T12), emphasizing the teacher's role as a facilitator rather than a direct instructor (T5) and fostering a collaborative and supportive classroom environment (T14).

Students recognized the value of collaborative learning and self-directed study in their educational experience.

> The topic in my class is taught that way, that the teacher tends to give us a topic, give us an opportunity to search for ourselves, but if we have questions, he is more than ready to help us. And he might even explain the whole topic if we cannot understand by ourselves, but he says it is always preferable for us to learn it by ourselves, because it will help us to actually understand the topic on a deeper level. (S11)

Challenges in Computer Science CLIL Classrooms

Although participants endorsed all the benefits outlined in the questionnaire, many of the challenges that are frequently discussed in the literature and commonly encountered by educators and students in other contexts were not identified as significant issues by participants of this study. The survey results revealed that although both teachers and students identified extra workload and lack of time as challenges in CLIL implementation, they did not perceive factors such as students' language proficiency, unsuitable textbooks, limited CLIL resources, or the reduced depth of subject information compared to monolingual classrooms as significant obstacles. Teachers and students differed in their views on teachers' English proficiency (Figures 3 and 4).

Figure 3. Teachers' Perceived Challenges of Teaching Computer Science in English (n = 35)

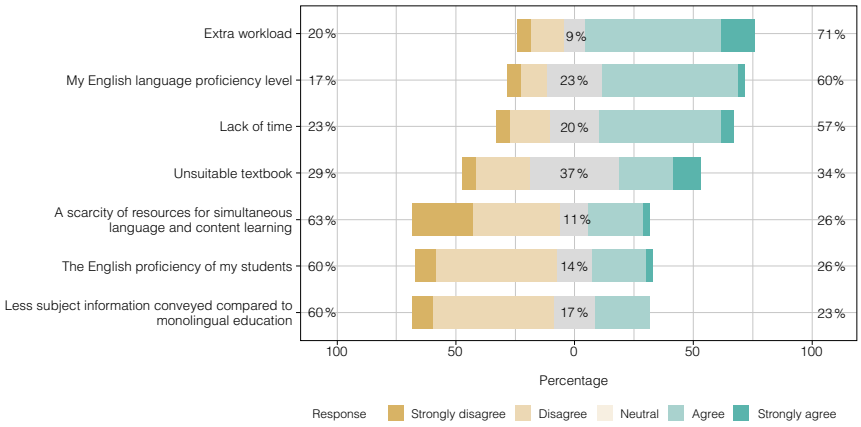
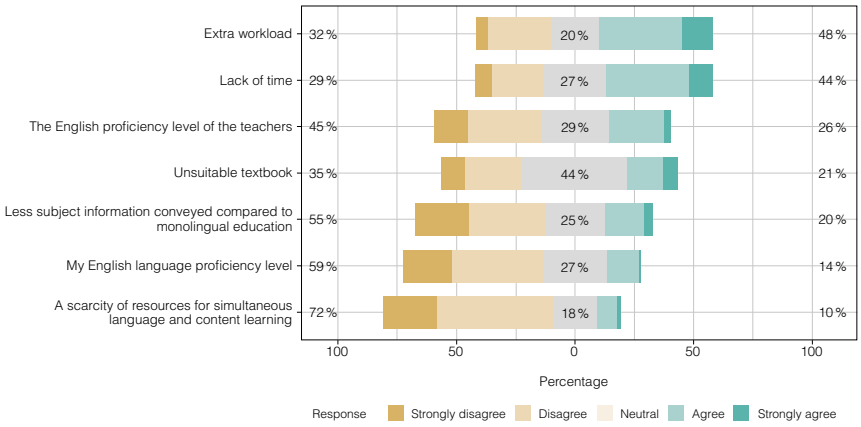


Figure 4. Students' Perceived Challenges of Learning Computer Science in English (n = 142)



Teacher's Language Barriers

Teachers, on average, were more likely than students to agree that their language proficiency created challenges (60% compared with 26%). The Mann-Whitney U test results indicated a significant difference in perceptions between teachers and students ($U = 1536$, $Z = -3.624$, $p < .001$), with a moderate effect size ($r = 0.272$). These findings align with interview responses, where teachers acknowledged personal challenges related to

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their English proficiency. For instance, one teacher reflected: "Maybe, in terms of my English proficiency, I feel the need to enhance it. There are not many issues. The school provides support, and my colleagues assist me in accessing materials. It is solely about my English" (T16).

The teachers who have come to the NIS relatively recently, with 1-2 years of experience, consequently with limited experience of CLIL, perceived their language level as a challenging factor.

> When I cannot express myself in English, I explain in Russian as an alternative. Because I cannot assert that I know English very well. Sometimes it happens; there are times when I cannot say certain terms and some words. But the good thing is that the English level of most of the children is very good. Therefore, sometimes students help me with English. (T4)

Teachers acknowledged that especially at the beginning of teaching their subjects in English, they faced significant challenges such as language barriers, limited familiarity with academic terminology and discomfort speaking in front of students. However, over time, teachers gained confidence and enriched their knowledge of English terminology in informatics and improved their CLIL practice:

> So, yes, the first time I had many difficulties in terms of English. You may know your subject well, but expressing it accurately in English can be a challenge. There are words you might mispronounce or articulate incorrectly, and students may struggle to understand you. (T16)

> When teaching in English, especially in the first year, we faced significant difficulties. There was the language barrier, the challenge of speaking in English in front of children, feeling uncomfortable and constrained. However, gradually, regardless of our current language proficiency level, we now confidently speak in front of children. (T8)

While many students perceived their teachers as proficient in English, others hold contrasting views. Although the survey showed that most students considered teachers' English proficiency to be sufficient, interviews revealed that some students experienced a gap between themselves and their teachers due to language barriers. One student shared:

> Personally, studying in Kazakh and Russian posed no difficulties previously, but upon entering 11th grade, I felt a language gap between us and our teachers. Their English proficiency might be lower

> than ours and sometimes insufficient to convey all the key points. They struggle a lot and end up giving us information in Russian or Kazakh, so we have to learn by ourselves through extra materials and books. (S8)

Another student observed: "Our lessons are not conducted entirely in English, which complicates our task. Overall, understanding in English is much easier than in Russian, as I mentioned before" (S6). Individual experiences and perceptions captured in the interviews revealed that some students see how some teachers struggle with explaining in English and perceived teachers' language barriers as affecting their learning experience.

Students' Diverse English Proficiency Levels

In contrast, neither teachers nor students perceived students' English proficiency as a significant challenge. Many interviewed teachers noted that most students have a notably high level of English proficiency. For instance, one teacher stated: "I believe that approximately 90-95% of students in our school do not face any language-related issues" (T2). Another teacher added, "Our students know English better than I do; some of them have an IELTS score of 8.0" (T3).

Teachers acknowledged that while students' English proficiency was generally sufficient, it varied: some students demonstrated very high levels, while others had average or slightly lower proficiency (T10, T15). This variability is reflected in their IELTS scores—for instance, 'one student may score 8.0, while another may only have 5.0' (T7). However, teachers noted that only 'a small fraction of students may need language support' (T10). Hence, students with comparatively lower English proficiency levels may face challenges, particularly in oral production during their CLIL classes. To support these students, teachers reported employing scaffolding techniques—an instructional strategy designed to aid students in comprehending content and acquiring language skills. One teacher elaborated: "I use a scaffolding approach to assist them. For example, I provide specific phrases, pose guiding questions, or initiate conversations, enabling students to continue" (T15).

The interviewed students reported minimal challenges with language comprehension or expression. One student remarked: "Problems

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with English? No, I do not remember" (S4), while another stated: "There was absolutely no language barrier in English" (S12). Additionally, S11 noted: "Other students might face challenges, but not me. I believe my level of English is just enough to learn computer science." However, a few students acknowledged minor difficulties. S10 explained that the primary issue lies in absorbing information, as speakers of Kazakh or Russian often need to translate their thoughts into English, which can hinder the learning process. S2 highlighted challenges related to comprehension, sentence structure, and the varying meanings of English words in different contexts. S3 and S5 mentioned occasional difficulties with understanding specific terms. Students noted difficulties at the start due to unfamiliarity with terms, but indicated that these issues lessened over time as they became used to studying in English.

Lack of Time and Extra Workload

Both teachers (60%) and students (44%) recognized the challenges and limitations posed by insufficient time (Figures 3 and 4). The interviews shed light on the time-related difficulties faced by both groups. Teachers often cited the struggle to find time to improve their English skills, emphasizing the demanding nature of the school schedule, filled with extracurricular activities and extensive work commitments. For example, one teacher shared her recent IELTS exam experience, scoring 5.5 and attributing the result to time constraints:

> If I had sufficient time, I could have achieved better results. However, time is limited due to various school events. For example, this week, students are taking the STA [Summative Term Assessment] exams, and we are grading their answers. Next week will involve events related to Nauryz [the New Year celebration in Kazakhstan], followed by many other activities such as Olympiads, projects, and meetings. (T1)

Another teacher mentioned that he had enrolled in English courses at a local language center but had to abandon them due to work commitments, making attendance difficult (T4). Similarly, T6 shared: "I attended language courses. Yes, you rush there after work, then come back tired, and you have to prepare for the next lesson, and so on. From this perspective, it was challenging."

For students, the lack of time becomes evident when they are unable to devote sufficient time to thoroughly explore a particular topic. This is because the curriculum covers numerous topics within a fixed time frame: "For example, we have just two hours for one topic, which can be insufficient. In such cases, we supplement our learning by watching videos on YouTube" (S5).

Although a higher percentage of teachers (71%) agreed that CLIL brings extra workload compared to students (48%), the Mann-Whitney U test shows that this difference is not statistically significant ($U = 2009.5$, $Z = -1.830$, $p = 0.067$). Integrating language learning into subject teaching requires extra time for planning, preparation, and delivery, as well as developing CLIL materials that meet both content and language objectives.

> If you are planning a CLIL lesson, then you need to really dedicate a lot of time to planning. What aspect of CLIL are you looking at? What resources do you have that can be used to deliver that lesson? So, I think the biggest challenge with CLIL, not challenges as such, but the disadvantage is the amount of time that you spend planning. (T10)

Teachers mentioned the benefit of joint planning for time-saving. "For parallel classes, such as the four Grade 11 teachers, we plan lessons together" (T4). They "decide on resources and strategies" (T17) and "distribute topics" (T9), with each teacher preparing lessons for specific weeks. This method helps manage workload, ensures a unified plan, and allows teachers to learn from each other.

Resource Availability

Survey results indicated that both teachers and students expressed a neutral opinion regarding the unsuitable textbook being a challenge. Figures 3 and 4 show that 37% of teachers and 44% of students refrained from indicating whether they agreed or disagreed. This neutrality may stem from the absence of textbooks for 11th and 12th grades in computer science. Participants mentioned only the AQA Computing AS (Langfield & Bond, 2008) and AQA Computing A2 (Langfield & Bond, 2009) books. Although these books do not cover all the topics of the curriculum, teachers suggest them to students as they can be helpful for external exam preparation.

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> Often, when we talk about academic language, we frequently reference these books, and we advise students to read these books. This is because one of the disadvantages of relying on internet sources is that each resource presents information differently, especially when it comes to specific terms. Moreover, most of the answers in exams are closely aligned with the content in these books, which provide a solid foundation. (T7)

However, some students have expressed some reservations: "We do not use textbooks for informatics in our lessons. The teacher creates a presentation for each class, sends it to us, and provides additional links and videos. We learn from all of that" (S5).

Teachers (63%) and students (72%) tended to disagree with the statement: "A scarcity of resources for simultaneous language and content learning" (Figures 3 and 4). Participants identified numerous useful online resources to support the study of computer science in English and highlighted resources for using the CLIL approach. According to teachers, transitioning to English instruction posed challenges primarily at the outset due to limited materials and resources. However, over time, these materials were refined, resulting in well-developed resources for each class, which in turn increased teachers' confidence.

> Initially, it was extremely challenging for both students and us, because our subject was previously taught only in Russian, and our material base was limited. Therefore, during the first years of transitioning to English instruction, we compiled a bank of materials over about two years. With the support of a foreign colleague, every day, we have been building this bank for two years. Now, when we compare to the first years, we feel quite confident. Nowadays, we just fine-tune assignments, making slight adjustments, around 10% to 15%, and deliver lessons with these changes. (T8)

Teachers have highlighted a collaborative resource bank on Microsoft Teams, created and maintained by computer science educators across the NIS network. This centralized repository contains lesson plans and educational materials accessible to all teachers (T2, T7).

> This initiative was launched during the pandemic. Teachers from all NIS schools shared their lesson plans and resources, organized by topic. We can access the works of other schools from there. In general, we have tons of resources, enabling us to choose the most suitable assignments. Across the NIS network throughout Kazakhstan, we have teachers who create excellent plans and presentations, from whom we gain valuable experience. (T9)

Less Subject Information Conveyed Compared to Monolingual Education: Dispelling This Challenge

According to quantitative data, both teachers and students disagree with the statement "Less subject information conveyed compared to monolingual education" (Figures 3, 4). Teachers feel that students' English skills are sufficient and that, with the use of appropriate approaches to support understanding, students can manage well. Additionally, if teachers struggle to explain or students struggle to understand in English, they can switch to their native languages when necessary.

Curriculum Related Challenges

Through the analysis of the interviews, a new theme concerning curriculum challenges emerged that was not addressed in the questionnaire. The dynamic nature of computer science presents a challenge for teachers.

> Theoretical materials in computer science pose a challenge because, unlike chemistry, biology, and physics, they are not stable. Due to constant changes in the field of IT, updates occur every day, even every hour. Therefore, the computer science teacher should always be updating [their knowledge]. (T7)

Due to this peculiarity of computer science, the curriculum for each grade undergoes a biennial review process by AEO NIS, gradually incorporating changes such as removing outdated topics and introducing new ones. Therefore, teachers must familiarize themselves with these topics and update their materials and resources accordingly.

Teachers also emphasized the demanding nature of the educational program at NIS, contrasting it with traditional schooling systems:

> There has been a significant change in the teaching process since I started working at NIS. When I arrived in 2014, my academic education was not sufficient for the curriculum in this educational system. Creating projects, getting students ready for external summative assessments, and considering university-level curriculum topics were all part of the process here. To be honest, it took us about a year to grasp everything. It felt like going through another round of university education. (T9)

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Discussion and Conclusion

The implementation of CLIL in computer science within Kazakhstan's trilingual education system, specifically at the NIS, reveals a nuanced landscape of benefits and challenges from both teachers' and students' perspectives. This study highlights that the most significant perceived advantage is access to high-quality English-language resources. Contrary to previous research where CLIL was primarily valued for language skill enhancement and sometimes seen as a barrier to content comprehension (e.g., Gámez Macías, 2020), this study shows that both teachers and students primarily view CLIL as a means to access superior educational materials.

Participants believe that English-medium instruction enhances their academic English proficiency, particularly in subject-specific vocabulary, aligning with findings from Mahan and Norheim (2021) and Zanoni (2021).

In contrast with other studies, particularly in STEM fields, where teachers often struggle to focus on language development (e.g., Block & Moncada-Comas, 2019), this study finds that external examination demands push teachers to emphasize academic language improvement, benefiting students' language skills.

CLIL is also seen as effectively preparing students for higher education and careers, consistent with Somers and Llinares (2018), Mahan and Norheim (2021), and Zanoni (2021). Teachers are motivated to enhance their language proficiency by incentives linked to their performance on language tests, such as salary increases or opportunities for international training. Additionally, CLIL encourages educators to shift from traditional teaching methods to a more student-centered approach, as noted by Bedeker et al. (2023).

Although students' English proficiency is deemed adequate, teachers acknowledge their own language skills as a limitation, echoing concerns from Andrew (2018). While Zanoni (2021) found that a teacher's lack of language competence in the L2 led to excessive content simplification, this study finds that teachers utilize all available languages, making the classrooms trilingual.

Unlike many studies where stakeholders perceive a lack of CLIL resources as a challenge, participants in this study do not share this view. They have established and continuously update a comprehensive bank of resources, both within their school and across a network of 21 schools.

Similar to McDougald's (2015) study, teachers in this research acknowledged that CLIL lessons require a considerable amount of time for planning and teaching. However, they could alleviate this challenge through joint planning.

Another issue uncovered in this study is the challenge posed by Kazakh terminology in computer science. Responses indicated that terms in students' native language often sound unfamiliar or awkward, leading them to prefer Russian and English equivalents. This preference can be attributed to historical, political, and economic factors that sustain Russian as "still a power-holding language in Kazakhstan" (Karabassova, 2020, p. 41). Consequently, many software interfaces are in Russian, further reinforcing the use of Russian terminology. Additionally, the underdeveloped translation systems for technical terms contribute to this preference.

The present study indicates a generally favorable view of CLIL among teachers and students in computer science, with a notable emphasis on the subject benefits rather than language development. However, to ensure the effective implementation of CLIL, it is imperative that careful consideration be given to the design of teachers' language training programs.

This study has several limitations. Firstly, data were collected through convenience sampling, which may not fully represent the broader population. Additionally, the study relies solely on self-reported data, which can be subject to biases and inaccuracies. Despite these limitations, the study provides valuable insights into practitioners' perspectives by identifying how they address various challenges. This can inform future efforts to improve practices and outcomes in the field.

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