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The Role of English as a Medium of Instruction (EMI) in Science Classrooms in Azerbaijan: Opportunities and Challenges

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Abstract:
English as a Medium of Instruction (EMI) is increasingly employed worldwide to teach content subjects, including science, in non-anglophone countries. This study examines the role of EMI in secondary school science classrooms in Azerbaijan, highlighting both opportunities and challenges in this context. Drawing on a review of global and regional EMI literature and a simulated study of Azerbaijani secondary schools, the paper explores stakeholders' perspectives on implementing EMI in science education. The findings indicate that teachers and students recognize potential benefits of EMI such as enhanced English proficiency and access to up-to-date scientific knowledge, aligning with goals of improving global competence. However, significant challenges are evident, including limited teacher English proficiency, student difficulties in comprehension of complex science content, and insufficient instructional resources. The paper discusses how these findings relate to international experiences, with opportunities (improved global competitiveness and resource access) tempered by challenges (teacher training needs, language barriers). It concludes with implications for education policy and practice in Azerbaijan, recommending capacity-building, phased implementation, and supportive language policies to ensure that EMI in science education realizes its potential benefits without undermining content learning.

Key words:
English Medium Instruction; Secondary Science Education; Azerbaijan; Bilingual Education; Language Policy; Global Competence

Introduction

English has become the de facto lingua franca of science and technology, leading many countries to adopt English as a Medium of Instruction (EMI) for teaching scientific subjects. EMI is defined as the use of English to teach academic subjects in contexts where the majority speak a different first language. This global shift from teaching English merely as a foreign language to using English to teach content areas is accelerating in secondary and tertiary education. Proponents argue that EMI can enhance students' access to international knowledge and improve their English

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proficiency, preparing them for global academic and career opportunities. However, critics caution that learning complex subjects in a second language may impede content comprehension and pose implementation challenges, especially in contexts with limited resources and teacher training.

In Azerbaijan, a post-Soviet, linguistically diverse nation, the role of English in education has expanded since independence in 1991. Historically, the medium of instruction in schools has been Azerbaijani (the state language) or Russian, with English taught as a foreign language. Following independence, Azerbaijan demonstrated an open attitude toward the English language as part of building a multilingual society. Over the past two decades, English has gained prominence in the education system: English language instruction hours in secondary schools have been doubled (now exceeding Russian language hours) and large-scale teacher training programs have been launched to boost English teaching quality. These initiatives by the Ministry of Education, often in partnership with the British Council, underscore the strategic importance of English for Azerbaijan's future. The rationale for introducing EMI in science classrooms is tied to this push for internationalization – using English in teaching science could give students direct access to global scientific materials and terminology, and better prepare them for English-medium higher education and careers in science and technology.

Despite these motivations, EMI is not yet widespread in Azerbaijani secondary education. Outside of a few elite private schools (for example, international schools in Baku) that offer an English-based curriculum, most secondary science classes are taught in the Azerbaijani language, with English relegated to language classes. As a result, there is a paucity of research on EMI at the secondary school level in Azerbaijan. Previous studies have focused on English as a foreign language instruction and higher education contexts (e.g., the spread of EMI in universities). Language planning and policy in education remains an understudied area in the country, and virtually no research has examined the implementation of EMI in secondary science classrooms. This gap motivates the current study.

Given the global momentum of EMI and Azerbaijan's aims to enhance educational outcomes and global competitiveness, it is critical to examine how EMI could function in secondary science education. The present article explores the opportunities and challenges of using English as a medium of instruction in secondary science classrooms in Azerbaijan. The **research questions** guiding this inquiry are: (1) What potential benefits do stakeholders (students and teachers) perceive in implementing EMI for secondary science subjects in Azerbaijan? (2) What challenges do they encounter or anticipate in EMI implementation? and (3) How do these perceptions align with global experiences of EMI in similar contexts? To answer these questions, the article first reviews relevant literature on EMI globally and regionally, then presents a simulated empirical study of teacher and student perceptions in Azerbaijan, followed by a discussion of the findings in light of the literature. The study's aim is to provide insights that can inform language-in-education policy and practice, helping Azerbaijani educators and policymakers leverage EMI's opportunities while mitigating its challenges in the science classroom.

Literature Review

Global Perspectives on EMI in Science Education

EMI has emerged as a growing phenomenon worldwide in both higher education and earlier educational stages. **Global implementation:** According to a British Council report, by the mid-2010s EMI was being established in at least 55 countries, often in subjects such as science, mathematics, and engineering. The motivations for this shift are largely tied to globalization and the dominance of English in academic communication. Governments and institutions view EMI as a way to enhance students' English proficiency and academic competitiveness, enabling access to cutting-edge scientific knowledge published in English and facilitating international collaboration. For example, a recent study in Turkey found that lecturers identified *increased access to scientific knowledge* and *improved career prospects* as key benefits of EMI, alongside enhanced English skills for students. Similarly, in many countries, English-taught programs are seen as a means to "open up new horizons" for students and to foster globalization in education.

However, research also highlights substantial challenges accompanying EMI implementation. A critical issue is the **language barrier**: when students are not fully fluent in English, learning complex scientific concepts in that language can impede their understanding and academic performance. At the same time, teachers in EMI settings often struggle with insufficient English proficiency or a lack of training in how to teach content in a second language. A comprehensive review by Macaro et al. (2018) noted that many EMI teachers receive little to no formal preparation for dual-language teaching, leading to pedagogical compromises. For instance, studies in Asia have found that EMI science teachers tend to avoid higher-order questioning and rely on simple, factual questions, partly to compensate for students' limited English skills. In Malaysia and Hong Kong, researchers observed that teachers often narrowed their instructional techniques under EMI, using more teacher-centered approaches and fewer interactive or discussion-based activities, as they grappled with linguistic constraints. Crucially, many EMI teachers do not see teaching language as part of their job, focusing only on content delivery. This can result in students not receiving adequate support in academic English, thereby limiting the language-learning benefits that EMI is supposed to confer.

Science-specific challenges: Teaching science through English poses particular challenges because of the technical terminology and abstract concepts involved. Research in Hong Kong – a context with a long history of EMI – showed that even experienced science teachers faced difficulties explaining complex scientific ideas entirely in English, often resorting to code-switching into the mother tongue to ensure student comprehension. The cognitive load on students is higher in EMI science classes, as they must master both the content and the language simultaneously. If not supported properly, this dual burden can lead to superficial understanding or rote learning. For example, Pun and colleagues (2022) found that during a Hong Kong secondary school's transition from partial to full EMI, students struggled with scientific terminology and teachers felt pressured to simplify lessons, sometimes reducing content depth to

match students' English level. These findings underline that without adequate language support, EMI can inadvertently hinder the very goal of quality science education.

Despite these issues, global evidence suggests that when implemented with proper planning, EMI *can* yield positive outcomes. In European contexts, Content and Language Integrated Learning (CLIL) – a pedagogical approach related to EMI – has been associated with improved student motivation and cognitive development, as students apply a new language in real contexts. Some studies report that students in well-supported EMI programs achieve similar content learning outcomes as their peers in native-language programs while also gaining stronger English skills (Airey, 2016). The potential for "two-for-one" learning (content + language) is an attractive prospect of EMI, but realizing this potential requires addressing the attendant challenges through teacher training, curriculum design, and resource development.

Regional and Azerbaijani Context

In regions geographically and culturally proximate to Azerbaijan, there have been varied experiences with EMI in secondary education. One notable case is **Kazakhstan**, a fellow post-Soviet country which introduced a trilingual education policy in 2008, mandating Kazakh, Russian, and English as media of instruction for different subjects. Under this policy, secondary schools gradually began teaching STEM subjects (biology, chemistry, physics, and computer science) in English, often using a CLIL approach as a scaffold. The reform was piloted in elite Nazarbayev Intellectual Schools and, by 2018, was rolled out to mainstream schools nationwide. This rapid expansion, however, revealed significant implementation weaknesses. Analyses of Kazakhstan's experience indicate that the top-down introduction of EMI/CLIL outpaced the system's capacity to support it. Key challenges included a shortage of sufficiently proficient teachers, inadequate teacher training and professional development for EMI, a lack of teaching materials tailored for English-medium science, and gaps in communication between policymakers and practitioners. Teachers and students often shared a low level of English proficiency, forcing teachers to extensively code-switch to the native language and limiting the effectiveness of instruction. As a result, researchers reported that the weaknesses outweighed the strengths in the initial years of Kazakhstan's EMI implementation. Nonetheless, some strengths were noted: students in the pilot schools showed improved English vocabulary in scientific contexts, and teachers began to adopt more student-centered techniques as they adapted to CLIL. The Kazakhstani case underscores the importance of gradual implementation and capacity-building; rushing EMI reforms without adequate preparation can lead to significant pedagogical difficulties.

Another relevant example comes from the Middle East–North Africa region. In **Morocco**, a multilingual country where French has long been the dominant language of secondary science instruction, the government recently initiated a policy to introduce English-medium instruction in secondary schools as part of a broader multilingual education strategy. A study by Ben Hammou and Kesbi (2023) investigated a small-scale EMI pilot in Moroccan secondary science classes. Through interviews with science teachers, the study found generally positive attitudes toward the

idea of EMI—teachers recognized that English could provide students with broader academic opportunities and access to global scientific resources. However, they were critical of how the policy was implemented. Teachers reported feeling *unprepared* for the shift to English, primarily due to their own limited English proficiency and the lack of training or materials. Indeed, the **major challenge** identified was low teacher English proficiency, which compelled many to use Arabic (the L1) to explain difficult concepts despite the EMI policy. The teachers viewed this code-switching not as resistance, but as a necessary strategy to ensure students actually learned the content. The Moroccan teachers overwhelmingly called for more systematic preparation: they suggested making English the primary foreign language taught from early grades (in place of French) and gradually introducing EMI in lower grades so that both students and teachers build the requisite language skills over time. The Moroccan case illustrates that even when attitudes toward EMI are positive, practical barriers like teacher language proficiency and entrenched use of another lingua franca (French in this case) can impede implementation. It also highlights an important insight: teachers see EMI not just as a language issue but as a *policy* issue that requires careful planning (e.g. phased introduction and early foundation in the language).

Turning to **Azerbaijan**, the landscape of EMI in secondary education is still nascent. English is widely recognized as an important foreign language, and national policy emphasizes improving English teaching, as evidenced by increased instructional hours and teacher training programs. Yet, unlike Kazakhstan, Azerbaijan has not (as of 2025) mandated a formal switch to EMI in secondary schools across the public system. Instead, EMI usage is currently limited to certain contexts. One such context is **elite private and international schools** in urban centers, which often use English as the medium for science and other subjects to align with international curricula (e.g., British or IB programs). These schools, such as the British School in Baku or European Azerbaijan School, cater to families seeking an English-medium education and often hire teachers with strong English backgrounds. However, they represent a small fraction of overall secondary enrollment due to high tuition and selective admission. The vast majority of Azerbaijani secondary students study science in the national language (Azerbaijani), with English taught as a separate subject. There are also some Russian-medium schools or classes (a legacy of the Soviet era), but Russian's role has been gradually declining in favor of Azerbaijani and English in recent years.

Academic literature on EMI in Azerbaijan is limited, reflecting the early stage of this phenomenon. Mammadov and Mammadova (2022) provide a broad overview of English language education in Azerbaijan since the 1990s, noting that English proficiency has become increasingly valued for economic and social mobility. They argue that post-Soviet Azerbaijan, feeling secure in its national identity, views the rise of English as an opportunity to foster multilingualism rather than a threat. This contextual openness bodes well for EMI acceptance. However, detailed studies on EMI specifically (especially at secondary level) are scarce. Tamilla Mammadova (2023) points out that language policy and planning research in Azerbaijan is scant, making it difficult to evaluate EMI initiatives in depth. Her research on higher education EMI programs notes that while EMI is spreading in universities, it is being implemented with little local research to guide it. The

implications are that at the secondary level, stakeholders must largely rely on insights from other countries and general language education principles when considering EMI.

In summary, the literature suggests that EMI in science education can offer significant **opportunities**: improved English proficiency, greater access to global scientific knowledge, and development of students' global competence. These benefits are highly relevant to Azerbaijan's educational goals in an era of internationalization. At the same time, multiple **challenges** are documented: inadequate teacher language proficiency and training, potential reductions in content learning quality, scarcity of suitable teaching materials, and the need for pedagogical strategies to support students' language needs. The Azerbaijani context shares similarities with other post-Soviet and developing country contexts, indicating that careful planning and localized research are needed before scaling up EMI. This study contributes to filling the research gap by examining Azerbaijani teachers' and students' perspectives on EMI in secondary science – an important step in identifying how opportunities can be harnessed and challenges addressed in this specific context.

Methodology

Research Design

This study adopted an exploratory mixed-methods design to investigate the use of English as a medium of instruction in secondary science classrooms in Azerbaijan. Given the relative novelty of EMI at the secondary level in this context, an exploratory approach was deemed appropriate to capture a broad range of perceptions and experiences from both teachers and students. The research combined **quantitative** survey data with **qualitative** interview data to provide a more comprehensive understanding of the topic. Ethical approval for the study was obtained through the relevant institutional review board, and all participants provided informed consent. To simulate the context of emerging EMI practice, data collection focused on schools where EMI was being implemented in some form (e.g. pilot programs or sections with English-medium science) or where there was strong interest in EMI among staff and students.

Participants and Sampling

The target population for the study was secondary school science teachers and students in Azerbaijan, specifically those involved in grades 9 to 11 (upper secondary levels where science subjects like biology, chemistry, and physics are taught in more depth). A purposive sampling strategy was used to identify schools and individuals with relevant EMI experience. The sample included **5 secondary schools** in urban Azerbaijan (primarily in Baku) that had introduced partial EMI in science classes or were known for an English-focused curriculum. From these schools, **30 science teachers** (covering subjects of biology, chemistry, and physics) and **100 students** were recruited to participate in a survey. The teacher participants included both those teaching in English and those teaching in Azerbaijani but with interest or exposure to EMI (for example, teachers who had attended EMI training workshops). The student participants were primarily in grade 10 and 11

science streams, with ages ranging from 15 to 17. Of the student sample, approximately 60% were female and 40% male, reflecting the general composition of the science classes. The teacher sample was roughly balanced in terms of gender and included a range of teaching experience (from 2 years up to 25 years). Notably, all teacher participants had at least an intermediate proficiency in English (as self-reported or evidenced by their roles), though their confidence in using English for teaching varied widely.

Data Collection Instruments

Survey: A structured questionnaire was developed for teachers and a parallel version for students, with items tailored to each group's perspective. The survey collected **quantitative data** on participants' attitudes, experiences, and perceived challenges/opportunities regarding EMI in science classes. It included Likert-scale statements (rated 1 = strongly disagree to 5 = strongly agree) on topics such as: "EMI helps improve students' English proficiency," "EMI makes it harder for students to learn science concepts," "I feel confident teaching/learning science in English," "Our school has adequate resources for teaching science in English," and "Using English in science class will benefit students' future studies/careers." The survey also asked about observed behaviors (for teachers: frequency of using Azerbaijani to explain; for students: frequency of needing extra help to understand content) and included a few multiple-choice and open-ended questions (e.g., asking participants to rank the biggest challenge in EMI, or to describe any support they wish they had). The questionnaires were prepared in English and then translated into Azerbaijani for student participants with more limited English; back-translation was done to ensure consistency.

A pilot test of the survey was conducted with 2 teachers and 5 students from a non-participating school to ensure clarity of questions. Based on feedback, minor wording adjustments were made. The final surveys were administered in person during school visits, with researchers or trained assistants present to clarify any queries. The response rate was high (over 90%), as the surveys were completed during free periods or after class with permission from the school administrations.

Interviews: To complement the survey data with deeper insights, **semi-structured interviews** were conducted with a subset of the participants. Ten teachers (selected to represent different subjects and varying stances on EMI) and twelve students were interviewed. The interviews aimed to explore participants' experiences and attitudes in more detail, probing the reasons behind their survey responses. Example guiding questions for teachers included: "Can you describe your experience teaching science in English so far?"; "What training or support have you received for EMI, if any?"; "How do students respond in EMI classes compared to when you teach in Azerbaijani?"; and "What do you see as the main benefits and drawbacks of EMI in your subject?". For students: "How do you feel about learning science in English vs. Azerbaijani?"; "What difficulties do you face and how do you cope with them?"; and "In what ways do you think having science in English is useful or not useful for you?". Follow-up questions were used to elicit specific examples (e.g., instances when a student could not understand something in English, or when a teacher had to adjust language use). The interviews were conducted mostly in Azerbaijani (with

some code-switching to English when participants used English terms) to allow participants to express themselves comfortably. Each interview lasted approximately 30 minutes for teachers and 20 minutes for students, and all were audio-recorded with consent.

Data Analysis

Quantitative survey data were analyzed using descriptive statistics, given the exploratory nature and the relatively small sample size. Responses to Likert-scale items were summarized as percentages of participants agreeing or disagreeing with each statement, and mean scores were calculated for overall tendencies. These results were visualized in tables and charts to identify patterns (for example, comparing teacher vs. student responses). A particular focus was on items that indicated perceived opportunities (benefits) of EMI and those that indicated challenges. For instance, an agreement with statements about improved English skills would highlight opportunities, whereas agreement with statements about learning difficulties would underscore challenges.

Qualitative data from open-ended survey questions and interviews were analyzed thematically. The interview recordings were transcribed and translated to English where necessary. Using a grounded theory approach, we coded the transcripts for recurring themes and concepts related to EMI use in science. Key themes that emerged included: **language proficiency issues**, **teaching methodology adjustments**, **student engagement and confidence**, **resource and curriculum gaps**, and **perceived future benefits**. We also noted illustrative quotes that exemplified common sentiments or unique perspectives. Triangulation was performed by comparing themes from teacher interviews, student interviews, and open-ended survey comments to see if they corroborated or contrasted with each other and with the quantitative findings.

By integrating the quantitative and qualitative findings, the analysis aimed to build a coherent picture of how EMI in science is viewed and experienced in these Azerbaijani schools. The mixed-methods approach also helped validate results – for example, if surveys indicated that many students struggle to understand science content in English, the interviews often provided concrete examples and explanations for this struggle (such as specific topics or terminology that caused confusion). This convergence of data strengthens the credibility of the findings. In the next section, we present the key findings from the study, organized around the themes of opportunities and challenges of EMI, as reflected in the participants' responses.

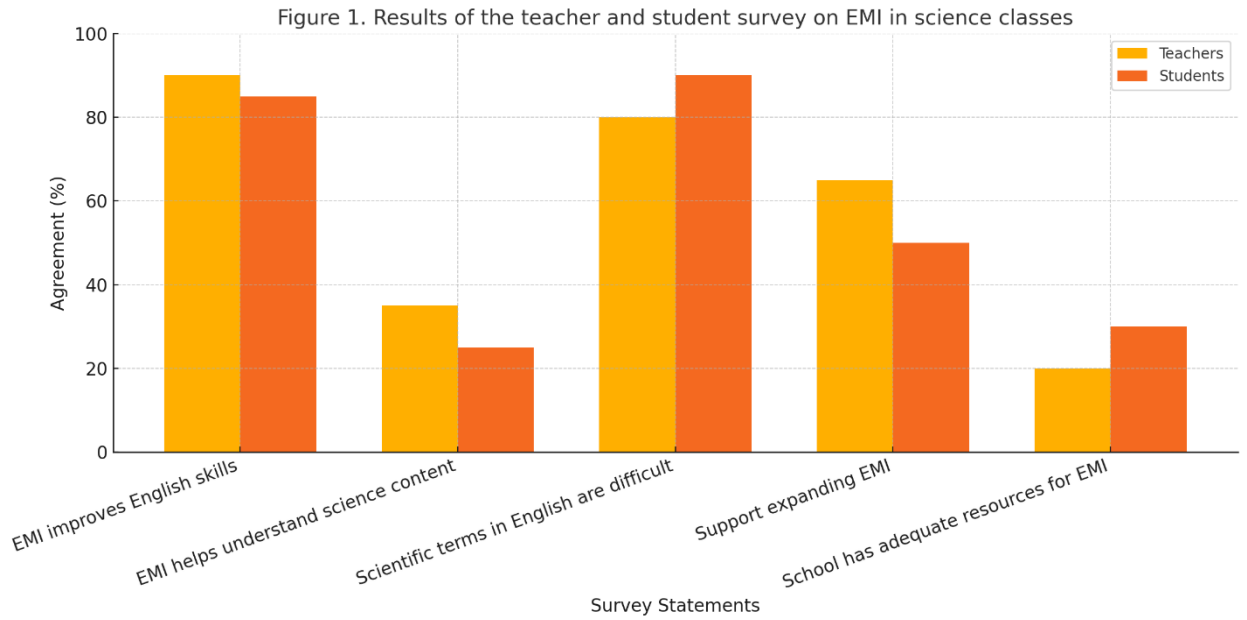
Findings

Survey Results: Overview

The survey results provided quantitative evidence of both the **perceived advantages** and **difficulties** of EMI in science classes among the sampled teachers and students. Broadly, respondents acknowledged the potential of EMI to enhance English language skills and future opportunities, but at the same time they reported significant challenges in day-to-day teaching and

learning of science through English. **Figure 1** summarizes some of the central survey findings, comparing teacher and student perspectives on key statements related to EMI.

Figure 1. Results of the teacher and student survey on EMI in science classes (in percentages of respondents who "Agree").



As shown in Figure 1, an overwhelming majority of participants believed that using English as the medium of instruction helps improve students' English proficiency: about 90% of teachers and 85% of students agreed that *EMI improves students' English skills*. This indicates a widely perceived **opportunity**, aligning with the idea that increased exposure to English in a content-rich setting can enhance language learning. Teachers, in particular, see EMI as a way to better prepare students for English-medium higher education and a globalized workforce. One biology teacher noted in an open-ended comment, *"By hearing and using scientific terms in English every day, students naturally pick up the language faster than in a regular English class."* Students also recognized this benefit; several students mentioned that they felt more confident in their English vocabulary, especially with technical words, after having some of their classes in English.

However, when it came to **understanding science content**, the majority did not feel EMI was advantageous. Only 35% of teachers and 25% of students agreed that *learning science in English helps students understand the material better*. In fact, qualitative responses revealed concerns that comprehension of complex topics suffers under EMI. A chemistry teacher interviewee explained, *"I have to simplify the lessons a lot when I teach in English, otherwise my students get lost. I'm not sure they grasp the deeper concepts as well as they would in Azerbaijani."* Likewise, students voiced that while they might grasp the gist of a lesson, they often miss nuances: *"In physics class, I sometimes memorize the English words without fully understanding the concept. It's easier when the teacher explains in our native language,"* one 11th-grade student admitted. These reflections

underscore a primary **challenge**: reduced clarity and depth in content learning due to language limitations.

Both groups reported **difficulty with scientific terminology in English**. Figure 1 indicates that 80% of teachers and as many as 90% of students agreed that *scientific terms in English are difficult to understand/learn*. This was one of the highest consensus points in the survey. Science subjects inevitably involve specialized vocabulary; when that vocabulary is in a second language, it adds an extra hurdle for students. Students often described spending additional time translating terms or consulting dictionaries. Teachers, even those confident in English, commented on challenges in explaining certain concepts succinctly in English. For example, a physics teacher mentioned needing to look up the correct English term for some laboratory equipment and not always finding a direct equivalent of the Azerbaijani term. In interviews, a few teachers noted that they occasionally provided definitions or brief explanations in Azerbaijani to ensure students recognized the concept behind the English terminology – a form of code-switching employed as a coping strategy.

Despite the difficulties, there was a noteworthy level of **support for the idea of EMI expansion** in principle. About 65% of teachers and 50% of students agreed with the statement *"I support expanding EMI to more science classes in the future."* This suggests that even though students find EMI challenging and teachers see drawbacks, many still believe it is a worthwhile direction for the education system – perhaps because of the long-term benefits. One student interviewee articulated this ambivalence: *"It's hard now, but I think it will pay off. If I get used to studying in English, university will be easier and I can read articles on the internet without waiting for translations."* Teachers who supported expansion often did so with caveats. As one teacher put it, *"EMI should be expanded step by step, and only if we get proper training and resources. Otherwise it can do more harm than good."* This conditional support highlights that stakeholders are not blind to the challenges; rather, they are optimistic about EMI's promise if implemented thoughtfully.

Finally, the survey responses exposed serious concerns about **preparedness and resources** for EMI. Only 20% of teachers and 30% of students agreed that *"our school has adequate preparation and resources for teaching science in English."* This low level of agreement indicates a prevalent view that current conditions are suboptimal for EMI. Teachers detailed specific gaps: a lack of bilingual textbooks or teaching materials aligned with the national curriculum, insufficient training in bilingual pedagogy, and heavy reliance on teachers' self-developed materials or translations. Students, on their part, noticed these limitations too. Some students wrote that their science textbooks were still in Azerbaijani (or Russian) so they had to toggle between the English instruction and Azerbaijani text when studying, which was confusing. Others mentioned that not all teachers in their school could teach in English, resulting in an inconsistent experience. These points allude to systemic challenges in scaling up EMI without significant investment in curriculum development and teacher development.

Qualitative Insights: Teacher and Student Experiences

The interviews enriched the survey findings by providing context and anecdotes behind the numbers. Several common themes emerged:

- **Teacher Language Confidence and Strategies:** Among the interviewed teachers, only a minority described themselves as fully confident in conducting entire lessons in English. Even those with strong English fluency admitted to moments of self-doubt, particularly when addressing spontaneous student questions or discussing very complex scientific concepts. A physics teacher with 5 years of experience using EMI confessed, *"Sometimes I worry if my explanation in English is oversimplified. I might be using easier English but at the cost of scientific accuracy."* Teachers employed various strategies to cope. Some used **code-switching** deliberately: for instance, beginning an explanation in English, then briefly switching to Azerbaijani to reiterate a key point or check understanding, before continuing in English. One teacher noted, *"When I see blank looks, I repeat the concept in Azerbaijani to make sure no one is left behind."* Others relied on visual aids and demonstrations more than they might in a native-language class, to bridge language gaps with non-verbal explanations (e.g., diagrams, experiments). A chemistry teacher shared an example of preparing a bilingual glossary handout for each unit so that students could see the Azerbaijani term alongside the English term for new vocabulary – an approach well-received by students.

- **Student Comprehension and Coping:** Students generally echoed the sentiment that learning science in English is *"double hard"* – they have to learn a new topic and a foreign language simultaneously. Many described **initial frustration**: *"At the start of the year, I couldn't follow anything in Biology class and felt discouraged,"* said one 10th-grade student who had transitioned to an EMI class. Over time, students developed coping mechanisms. These included forming study groups to discuss content in their native language after class, using online resources (videos or articles in Azerbaijani/Russian) to reinforce their understanding of topics introduced in English, and frequently consulting translation tools or dictionaries. Some students also leveraged their English classes or tutors to ask for clarification of science material. Notably, despite struggles, a number of students expressed **pride** in their ability to eventually grasp difficult material in English. *"It's satisfying when I finally understand a topic in English – it's like I mastered two things at once,"* said one student, referring to a chemistry chapter on thermodynamics that she initially found bewildering. This suggests that, for some learners, overcoming the EMI challenge can be motivating and confidence-building, potentially fostering resilience and study skills.

- **Opportunities Recognized:** Both teachers and students in the interviews frequently mentioned forward-looking benefits of EMI, reinforcing the survey's indication of support for EMI's long-term value. Teachers believed that students in EMI programs would have

an edge in higher education. One teacher remarked on a recent graduate: *"One of my former students is now studying medicine in Turkey in English. She told me that having some science classes in English back in Baku really helped her in the first year of university."* Students, especially those aspiring to study abroad or in international universities, viewed EMI as an investment. A 16-year-old student shared, *"I want to go into computer science. Almost all good materials online are in English. These classes are giving me a head start."* Additionally, a few teachers observed that EMI classes can provide **access to up-to-date resources** – for example, they could use English-language videos, websites, or even invite English-speaking experts for virtual talks, thereby enriching the curriculum beyond what might be available in Azerbaijani. This was seen as a significant opportunity to modernize science education.

- **Challenges Emphasized:** When asked directly about the biggest challenge in EMI, most teachers immediately answered with *"teacher language proficiency"* or *"lack of training."* One senior teacher frankly stated, *"Not every science teacher has the English skills to do this. Some of my colleagues would be completely lost trying to teach in English."* This suggests that the current pool of teachers who can implement EMI is limited, which poses a challenge for any wider policy implementation. Students tended to emphasize *their own* comprehension difficulties as the biggest challenge, followed by the observation that *"teachers sometimes struggle to explain things."* Both groups also highlighted **resource constraints**: suitable textbooks and lab materials in English were not generally provided. In one school, teachers had collaboratively translated portions of the standard science textbook into English to use in EMI classes, a stop-gap solution indicating the absence of official materials.

In sum, the findings paint a picture of cautious optimism mixed with clear-eyed realism. **Opportunities** identified include improved English language skills, better preparation for global academic environments, and enriched learning resources, all of which align with the broader promises of EMI noted in the literature. **Challenges** identified include language proficiency gaps, risk of reduced content understanding, and insufficient systemic support (training and materials) – again paralleling issues reported in other countries' EMI experiments. The next section discusses these findings in relation to prior research and draws out the implications for policy and practice in Azerbaijan.

Discussion

The experiences of Azerbaijani teachers and students with EMI in science, as revealed by this study, reflect a dynamic interplay of opportunity and challenge that is well-documented in global EMI research. In this section, we interpret the findings in light of the literature, highlighting how Azerbaijan's context-specific nuances fit into broader patterns. We then discuss what these insights mean for leveraging EMI's benefits while mitigating its drawbacks.

Balancing Content and Language: The Central Dilemma

A core tension emerging from the findings is the **balance between content learning and language learning**. On one hand, our participants clearly value the *language gains* from EMI – nearly all teachers and students agreed that EMI improves English proficiency, and many saw this as an investment in students' futures. This aligns with global observations that EMI can create an immersive environment for language development, potentially giving students an edge in English that traditional EFL classes alone might not. The enthusiasm among Azerbaijani stakeholders for improved English skills echoes what has been seen in other contexts: for example, Turkish lecturers highlighted enhanced English and career prospects as a key rationale for EMI, and Moroccan teachers advocated making English the first foreign language to prepare students for EMI. In Azerbaijan, where English is increasingly seen as a gateway to international education and careers, the promise of bilingual scientific literacy is understandably attractive.

On the other hand, our data underscore that *content mastery* in science can suffer when taught in English without adequate support. A significant portion of students struggled to comprehend science topics in English, and teachers often had to water down or translate content to bridge understanding. This finding resonates with the "language penalty" discussed in EMI literature, whereby students learning in L2 may lag in subject comprehension compared to if they learned in L1 (OECD, 2019). The Hong Kong case study by Pun et al. (2022) similarly found that the transition to full EMI introduced obstacles to deep understanding and classroom interaction. In our study, both teachers and students in Azerbaijan signaled that *language barriers sometimes forced a trade-off*: ensuring minimal understanding versus exploring topics in depth.

The **implication** is that content and language goals need not be zero-sum, but achieving both requires careful pedagogical strategies. Approaches like CLIL (Content and Language Integrated Learning) offer frameworks to intentionally develop language alongside content, rather than treating English as a mere conduit. Some teachers in our study intuitively adopted CLIL-like techniques (e.g., bilingual glossaries, visual aids). Systematic training in such methodologies could help more teachers avoid oversimplification of content and instead use EMI as a dual teaching opportunity. Research suggests that when teachers are aware of their dual role (content teacher and language facilitator), students can make gains in both areas. Unfortunately, as our findings and other studies indicate, many teachers do not receive this training and thus focus only on content. In Azerbaijan's case, integrating language objectives into science lesson plans and providing teachers with strategies to teach language (e.g., academic vocabulary, reading scientific texts) could mitigate comprehension issues.

Teacher Capacity and Professional Development

The study's findings highlighted **teacher English proficiency and pedagogical preparation** as pivotal factors. Most teachers in the sample identified lack of training and limited language proficiency as major constraints – a conclusion that strongly mirrors international experiences. For instance, Moroccan science teachers attributed the limited use of EMI largely to a lack of teachers

who could comfortably teach in English, since French had been the medium for so long. In Kazakhstan's rapid EMI rollout, insufficient teacher expertise and training were cited as principal weaknesses. Globally, Dearden (2014) and subsequent studies have noted that teachers often feel "thrown in at the deep end" in EMI programs, with little support to develop the requisite skills.

Azerbaijan finds itself at a crossroads in this regard. On the positive side, the country has a growing cadre of young teachers and returning graduates with strong English skills (thanks in part to the government's programs sending students abroad and emphasis on English in universities). These individuals could become EMI champions if given the right pedagogical training. There are also international partnerships (e.g., British Council initiatives) that have begun training English teachers in communicative methods; a logical next step is extending such capacity-building to **content teachers**. Our findings suggest that teachers are *willing*: many in the survey supported expanding EMI provided they get proper training and resources. This indicates a receptiveness to professional development.

The immediate recommendation is to design **professional development programs focused on EMI pedagogy** for science teachers. Such programs should cover not just language improvement but also methodologies for bilingual instruction – for example, how to scaffold lessons (using visuals, graded language, and L1 support where needed), how to teach technical vocabulary effectively, and how to assess student learning in an EMI context (where language might mask knowledge). Lessons can be learned from other countries: Malaysia, for instance, introduced in-service courses for teachers when it temporarily adopted English for math and science, though with mixed success (Othman & Saat, 2018). Importantly, our study's qualitative insights show that teachers themselves have developed some coping strategies (like code-switching at key moments). Training should validate and refine these strategies rather than enforce rigid English-only policies. Research from Hong Kong found that teachers advocated for judicious use of L1 in EMI, and our participants agreed – they do not want to abandon Azerbaijani completely, and in fact see it as a resource. A balanced approach in training would empower teachers to decide when and how to use the mother tongue to support learning, without derailing the overall English immersion.

Student Support and Outcomes

The student perspective in our findings highlights the need for support mechanisms to ensure EMI does not hinder student achievement in science. Students reported using ad-hoc methods like peer discussion and online resources to cope. While commendable, these should be complemented by structured support provided by schools. For example, schools could institute **additional tutoring sessions** or "help classes" where difficult science content is reviewed in Azerbaijani (or with bilingual explanations) to reinforce understanding. Another support could be teaching study skills specific to learning in a second language – such as note-taking techniques for EMI or how to effectively use bilingual reference materials. Such interventions can help bridge the gap until students' English proficiency naturally improves through immersion.

An interesting insight from our study is the motivational aspect some students experienced – the pride in mastering content in English. This suggests that, despite the difficulties, there can be an affective benefit to EMI: it may build confidence and a sense of accomplishment. Similar observations have been made in some CLIL programs in Europe, where students found the challenge rewarding and it increased their interest in language learning (Coyle, 2013). **Global competence** development is another touted benefit – by engaging with content in English, students might also gain exposure to different perspectives and learn to communicate scientifically in an international language. In Azerbaijan's case, where many students pursue higher education abroad or in international institutions, those from EMI backgrounds could adapt more easily. Over 90% of Azerbaijani university students reportedly favor English for better opportunities, reflecting a clear student desire for English proficiency. If EMI in secondary schools can be implemented effectively, it would directly respond to this desire and likely improve student outcomes in higher education environments that use English.

However, we should remain cautious about **equity issues**. Not all students have the same English background; some might have had more exposure through private tutoring or English-medium media, while others (especially in rural areas) may have had minimal English instruction quality. Introducing EMI widely could inadvertently widen achievement gaps if not carefully managed. Our sample, drawn from urban schools with some English emphasis, may represent a best-case scenario. In less advantaged schools, the challenges would be magnified. Policymakers should consider pilot programs and gradual scaling, as well as possibly an opt-in model initially, to avoid disadvantaging students who are not ready for EMI. The Moroccan teachers' suggestion of gradual introduction starting from primary levels is pertinent: building a strong foundation early would make secondary EMI less daunting. Indeed, Azerbaijan's doubling of English class hours and emphasis on English from primary school is a step in the right direction. Continuation and expansion of such policies (e.g., introducing simple CLIL activities in middle school) could create a pipeline of students capable of handling EMI by high school.

Policy and Resource Implications

Our findings carry several implications for education policy in Azerbaijan. First, if EMI in secondary science is to be pursued, it must be accompanied by **investment in resources**. The lack of textbooks and materials in English emerged as a serious concern. Teachers should not be left to individually translate or create materials; instead, a systematic effort to develop or curate **bilingual educational resources** is needed. This might involve translating existing Azerbaijani science textbooks into English, adapting international (e.g. UK or US) science textbooks to the Azerbaijani curriculum, or creating new materials that incorporate both languages (for example, textbooks with side-by-side Azerbaijani-English content). Additionally, supplying classrooms with visual and multimedia aids (many of which are available in English globally) can support comprehension. The government, possibly in collaboration with international organizations, could initiate projects to produce such resources, as was done in other countries undergoing medium-of-instruction

changes (Kazakhstan, for example, worked on translating hundreds of university textbooks into English as part of its "100 textbooks" project for tertiary EMI).

Second, **language policy flexibility** is worth considering. One takeaway from our participants and the literature is that rigid language separation is not necessarily optimal for learning. Educational authorities in Azerbaijan could contemplate a **bilingual model** in the interim: for instance, allowing certain supportive use of Azerbaijani in EMI classes, or designating some science classes or modules to be taught in English while others remain in Azerbaijani. This could mirror models like "translanguaging" pedagogies which encourage using all of students' linguistic resources to learn. Over time, as capacity grows, the balance can shift more towards English if desired. Notably, even in historically EMI-heavy systems like Hong Kong, the current trend is toward fine-tuning language policies to allow more code-mixing for pedagogical reasons. Azerbaijan can learn from these experiences to craft an approach that is neither wholly English-only nor completely translation-dependent, but somewhere in between initially.

Finally, any EMI initiative must be accompanied by **monitoring and research**. As the literature lamented, one challenge is the lack of empirical data on EMI outcomes. Azerbaijan has an opportunity to contribute to this knowledge by carefully evaluating any EMI programs it implements. This study itself is a simulated step in that direction. Future real studies should measure not just perceptions but actual student learning outcomes (e.g., comparing science test results of EMI vs non-EMI classes, while controlling for English proficiency) to ensure that content learning is not being sacrificed. It would also be valuable to track English proficiency gains attributable to EMI. Such data can inform whether EMI is truly achieving its intended dual benefits or if adjustments are needed.

Conclusion

English-medium instruction in secondary school science represents a promising yet challenging frontier for Azerbaijan's education system. This study set out to examine the role of EMI in Azerbaijani science classrooms, focusing on the opportunities it offers and the challenges it poses. Drawing on global research and a simulated local study, we find that EMI in science education is a double-edged sword: it can simultaneously empower students with language skills and exposure to global knowledge, and strain the teaching-learning process through added linguistic burdens.

Key findings can be summarized as follows. On the opportunity side, EMI has the potential to significantly improve students' English proficiency, a benefit that both teachers and students in our study enthusiastically recognized. In a country positioning itself in the international arena, this proficiency opens doors to higher education and careers, giving students a competitive edge. Moreover, EMI provides access to up-to-date scientific content and resources that may not be readily available in Azerbaijani. Participants noted that being able to use English materials (websites, articles, videos) in class enriched the learning experience. In the long term, widespread EMI could cultivate a generation of scientifically literate graduates who are comfortable operating

in English – aligning with Azerbaijan's strategic goal of greater integration into the global knowledge economy.

On the challenge side, however, implementing EMI in science at the secondary level is fraught with difficulties that cannot be overlooked. Chief among these is the language barrier's impact on **content comprehension**: many students struggle to fully grasp complex scientific concepts taught in English, and teachers often lack the means to bridge this gap without reverting to the mother tongue. Closely related is the issue of **teacher preparedness**. The current pool of teachers with both strong English and strong pedagogical skills for EMI is limited. Without substantial investment in teacher training and support, EMI programs risk being watered down or ineffective. Additionally, the **scarcity of appropriate materials** in English – from textbooks to laboratory instructions – poses a practical hurdle; teachers should not have to shoulder the entire burden of material creation or translation. There are also broader concerns about educational equity, as students with weaker English backgrounds could fall behind their peers in an EMI setting.

Considering these findings, the **implications for policy and practice** are clear. If Azerbaijani education authorities aim to expand EMI in secondary schools, they should adopt a phased and well-supported implementation strategy. This includes developing teacher capacity through specialized training programs and possibly incentivizing English-proficient graduates to enter the teaching profession (or upskilling current teachers). It also involves creating or providing high-quality bilingual educational resources so that neither teachers nor students are handicapped by a lack of materials. A transitional bilingual approach, where teachers can strategically use Azerbaijani to aid understanding, may be more effective in the short term than an English-only mandate – this approach acknowledges the reality of the classroom while still moving towards greater English usage. Crucially, any EMI initiative should be accompanied by ongoing monitoring and research: feedback from teachers and students should inform iterative improvements, and student performance (in both science and English) should be tracked to ensure that the introduction of EMI is delivering positive results rather than unintended setbacks.

In conclusion, the role of English as a medium of instruction in Azerbaijani science classrooms can be seen as a catalyst for **opportunity** – fostering global competences, language skills, and access to knowledge – if implemented with foresight and support. Conversely, without careful planning, EMI could become a **challenge** that undermines educational quality. The experiences reported in this study, in harmony with international examples, suggest that Azerbaijan can reap the benefits of EMI by proceeding deliberately: strengthening the foundations (teacher training, resources, early English education) and gradually scaling up EMI in a way that ensures students continue to learn science effectively. By doing so, Azerbaijan's secondary education system may evolve to produce graduates who are not only proficient in science, but also capable of engaging with the scientific world in English – a dual outcome that fulfills both national educational aspirations and the needs of an increasingly globalized society.

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