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EXPLORING TEACHERS' PERCEPTIONS OF TRANSLANGUAGING AND TECHNOLOGY IN ENGLISH-MEDIUM STEM CLASSROOMS IN KAZAKHSTANI SECONDARY SCHOOLS

This study examines the integration of English-Medium Instruction (EMI) and translanguaging practices in STEM education within private secondary schools in Astana, Kazakhstan. Drawing on the TPACK framework, extended to include multilingual pedagogies, the study investigates how these strategies support student engagement and comprehension. Using a phenomenological approach, data were collected through interviews and observations with six teachers across four private schools in Astana. Findings reveal that translanguaging is commonly used to scaffold content and address language barriers, yet it remains informal and unsupported by policy. Technology is primarily used for content delivery and it is rarely aligned with multilingual teaching practices. The separation of these tools limits their potential to foster inclusive and effective learning. The study contributes a Multilingual TPACK framework and recommends professional development and policy changes to integrate translanguaging with digital tools in EMI-STEM contexts. These insights are critical as Kazakhstan expands multilingual education within secondary STEM subjects.

Keywords: EMI, STEM, translanguaging, multilingual education, TPACK framework, technology in education.

Introduction

Kazakhstan's commitment to multilingual education has grown significantly in recent years, particularly through the implementation of English Medium Instruction (EMI) in STEM (science, technology, engineering, and mathematics) subjects. Introduced under the Trilingual Policy in 2007 and reinforced by Kazakhstan's adoption of the Bologna Process in 2010, EMI is positioned as a pathway to global integration, scientific literacy, and economic competitiveness [1, 2]. While special-purpose schools such as Nazarbayev Intellectual Schools (NIS) and Bilim-Innovation Lyceums (BIL) have pioneered EMI-STEM implementation with strong institutional support, private and mainstream schools with less selective admissions face persistent challenges**,** including student language barriers, limited teacher training, and a lack of cohesive multilingual pedagogical strategies [3, 4].

In this context, translanguaging has become a widely used but unofficial classroom strategy. It allows teachers and students to fluidly move between Kazakh, Russian, and English to scaffold comprehension and engagement in STEM learning [5, 6]. While studies have emphasized translanguaging's value in bilingual education, less is known about its application in EMI-STEM classrooms, where content demands are high and language support structures are often weak. Moreover, despite the Ministry of Education's promotion of digitalization, teachers often report using technology mainly for content delivery—rather than as an interactive or multilingual support tool [7, 8].

The lack of integration between translanguaging and technology represents a missed opportunity in multilingual STEM education. While both strategies are used independently to support student learning, they are rarely aligned in a purposeful, theory-driven way. This disconnection raises the need for a more comprehensive pedagogical model that accounts for linguistic diversity alongside technological and content-based instruction.

To address this gap, this study applies the Technological Pedagogical Content Knowledge (TPACK) framework [9], extended to include translanguaging as a core pedagogical component [10]. TPACK traditionally focuses on how teachers integrate technology into subject-specific instruction, but it has been critiqued for its monolingual assumptions.

While much of the existing literature on EMI in Kazakhstan focuses on higher education or elite secondary schools, this study focuses on private, non-special-purpose secondary schools, where linguistic diversity is high and institutional support varies. The purpose of the research is to explore how teachers in these settings perceive and implement translanguaging and technology as part of EMI-STEM instruction. It specifically investigates how these strategies shape student engagement, comprehension, and equitable access to STEM learning.

Research Questions

1. How do teachers experience the implementation of English-medium STEM education within Kazakhstani lower secondary schools?
2. What challenges and opportunities do teachers observe for students from diverse backgrounds in their classrooms?
3. How do teachers promote student engagement to improve academic outcomes?
   a. How, if at all, do teachers use translanguaging?
   b. How, if at all, do teachers integrate technology?

Guided by a phenomenological approach, the study draws on semi-structured interviews and classroom observations with six STEM teachers across four schools in Astana. By capturing teachers' lived experiences and instructional practices, the study aims to highlight how translanguaging and digital tools can be more effectively integrated into EMI-STEM frameworks. The findings contribute to the development of more inclusive educational strategies and inform teacher training, curriculum design, and EMI policy in Kazakhstan's evolving multilingual landscape.

Literature review

English-medium instruction (EMI) in STEM education has expanded rapidly in Kazakhstan, aligning with global trends and the national Trilingual Policy promoting Kazakh, Russian, and English [1, 2]. In this multilingual context, teaching science and mathematics through English poses significant challenges for both teachers and students, especially in non-elite schools with varying linguistic backgrounds and limited support systems [3, 4].

Translanguaging has emerged as a key strategy in these settings. Unlike traditional code-switching, translanguaging is a fluid use of the entire linguistic repertoire, facilitating meaning-making across languages [5, 11]. It supports comprehension and student engagement by allowing teachers to explain complex STEM concepts using students' L1s, such as Kazakh or Russian [6, 12]. Research has shown translanguaging also boosts metalinguistic awareness and fosters inclusive classroom environments [13]. However, tensions persist. Translanguaging remains largely informal and unsupported by national policy, with dominant languages (e.g., English) often privileged over minority languages [14, 15]. Teachers report using translanguaging as a workaround rather than a pedagogically sanctioned strategy, leading to inconsistencies in practice [6].

Parallel to language challenges, the integration of technology in EMI-STEM has grown, especially under digitalization initiatives in Kazakhstan [7]. Technology-enhanced tools like simulations, videos, and apps are widely used for content delivery but rarely adapted to multilingual needs [8]. Teacher-centered tech use dominates due to time constraints, limited training, and English-only interfaces [16, 17].

The TPACK framework (Technological Pedagogical Content Knowledge) provides a lens to analyze these dynamics [9]. TPACK emphasizes the intersection of content knowledge, pedagogy, and technology. In EMI-STEM classrooms, TPACK is relevant but incomplete as it lacks attention to language diversity. Scholars have called for its extension to multilingual contexts, integrating translanguaging as part of pedagogical content knowledge [10, 18].

Beyond these separate concepts, the framework emphasizes the points where they intersect:

- Technological Pedagogical Knowledge (TPK) about understanding how to use technology to improve teaching methods;
- Technological Content Knowledge (TCK) as the ability to use technology to deliver information in an understandable manner.
- Pedagogical Content Knowledge (PCK) as using pedagogical techniques in line with certain subject requirements [19, 20].

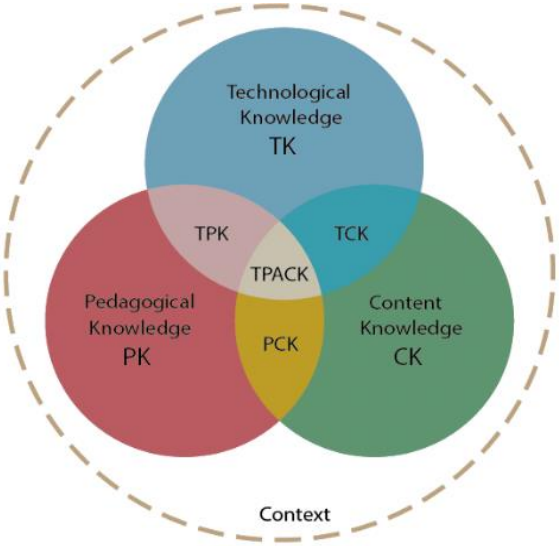

Figure 1 - The TPACK Framework

Note. The TPACK framework, illustrating the interplay of technological, pedagogical, and content knowledge is from http://tpack.org.

This study responds to that gap by proposing a Multilingual TPACK framework (Figure 2) by incorporating translanguaging as a pedagogical component, recognizing that a monolingual TPACK approach may not fully support students' comprehension in diverse settings [10]. While the study primarily examines the independent roles of technology and translanguaging, it considers their potential synergy, such as multilingual digital resources, as a secondary interest. This approach aligns with culturally responsive teaching, promoting equitable learning in EMI-STEM classrooms.

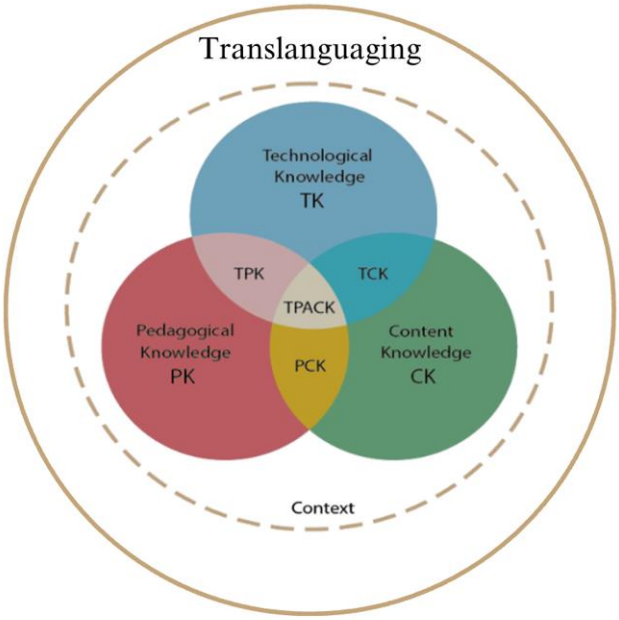

Figure 2 - Translanguaging-Integrated Multilingual TPACK Framework

Note. The Translanguaging-Integrated Multilingual TPACK Framework, developed for this study, extends the TPACK model [21] to incorporate translanguaging practices in multilingual EMI-STEM classrooms.

While treated as separate strategies in current practice, combining them could address both linguistic and cognitive demands in STEM instruction. Yet no research in Kazakhstan has explicitly explored this intersection from the teacher's perspective, particularly in private non-elite secondary schools.

By examining how teachers experience and apply translanguaging and technology in EMI-STEM classrooms, this study builds on and extends prior work in CLIL, EMI, and multilingual education, offering theoretical and practical insights into inclusive, effective teaching in Kazakhstan and similar multilingual contexts.

Materials and research methods

This study employed a qualitative phenomenological approach to explore how EMI-STEM teachers in Kazakhstan use translanguaging and technology in multilingual classrooms. The research aimed to uncover the lived experiences of teachers, focusing on the meanings they assign to their pedagogical decisions. Participants were selected using purposeful and snowball sampling techniques. Six secondary STEM teachers (biology, chemistry, physics, mathematics) from four private schools in Astana participated. The four different types of schools were selected according to their language policy and content focus:

- 1 private STEM school whose curriculum prioritized STEM subjects through the adoption an international curriculum (STEM school)
- 1 technology-focused private school that integrates an international curriculum (Tech school)
- 1 private school with diverse students whose international curriculum prioritized full EMI immersion (International school)
- 1 international school following the IB model (IB school)

Data collection involved semi-structured interviews and non-participant classroom observations. Interviews allowed for in-depth exploration of teacher beliefs and strategies, while observations focused on real-time instructional practices involving translanguaging and technology. Interviews were conducted in the teachers' preferred language (Kazakh, Russian, or English) to ensure comfort and authenticity.

Data were analyzed using Braun and Clarke's [22] thematic analysis, adapted to a phenomenological lens. Codes were developed inductively and aligned with TPACK domains and translanguaging practices. Triangulation between interview and observational data enhanced validity. This methodology enabled a nuanced understanding of how teachers integrate (or fail to integrate) technology and multilingual pedagogy in EMI-STEM classrooms.

The findings from this study are presented thematically and aligned with the five research questions. The first theme explores teachers' overall experiences with EMI-STEM implementation, responding to Research Question 1. The second theme focuses on the challenges and opportunities teachers encounter in multilingual classrooms, addressing Research Question 2. The third theme highlights strategies teachers use to enhance comprehension and student engagement, directly related to Research Question 3. Themes four and five explore how translanguaging and technology are used in practice, responding to Research Questions 4 and 5. A final theme discusses the disconnect between translanguaging and technology, emphasizing a missed opportunity for integration. Together, these findings offer a comprehensive view of how EMI-STEM teachers navigate multilingual and technological demands in their classrooms.

Results and discussions

Teachers' Experiences with EMI-STEM. Teachers across all school types described EMI-STEM education in Kazakhstan as experimental and evolving. While the Ministry of Education and Science of RK promotes English as a medium to foster global competitiveness, many teachers reported a lack of standardization and resources, particularly in non-specialized schools. Teachers expressed concern that EMI often prioritized English over content mastery, especially for newcomers with low language proficiency. Teacher B (Biology, Tech school) shared, "Teachers usually teach science only theoretically," underscoring the disconnect between theory and real-life application.

Despite these constraints, many teachers viewed EMI-STEM as an opportunity to motivate students and encourage international perspectives. Teacher A, a physics instructor at a STEM-focused school, supported this view, saying, "Most universities require English proficiency for STEM majors, so students who learn these subjects in English now will have a much smoother transition later." While they acknowledged EMI-STEM's potential to enrich students' learning and prepare them for global opportunities, teachers emphasized the need for, more practical, hands-on approaches, stronger teacher training programs, improved access to technology and resources across schools, and clearer frameworks for implementing STEM nationwide.

Challenges and Opportunities

Participants reported a complex mix of challenges and opportunities in implementing EMI-STEM instruction in multilingual classrooms. One of the most pressing challenges was the persistent language barrier, especially for newcomer students who lacked academic English proficiency. This often-required teachers to slow down instruction or repeat explanations in multiple languages. Teacher F (Chemistry) explained, "When you're already spending extra time making sure students understand the concepts in English, there's not always room for more activities," illustrating how linguistic needs directly impacted lesson pacing.

Time constraints were closely linked to another challenge—balancing competing curricula. Teachers frequently noted the difficulty of reconciling national standards with international expectations, which created planning overload. Furthermore, many described the shortage of bilingual STEM materials and the absence of institutional policies supporting L1 use as systemic barriers.

Despite these issues, teachers identified valuable opportunities as well. Many noted that EMI-STEM created access to global knowledge through updated digital resources and international content. Students were often enthusiastic about using English and engaging with multimedia platforms, which enhanced motivation. In addition, some teachers highlighted access to professional development and opportunities for international collaboration as enabling factors. These positive aspects, however, were usually dependent on the type of school and its resources, underscoring disparities across institutions. Overall, while teachers saw potential in EMI-STEM to enrich student learning, they remained constrained by policy gaps, limited materials, and inconsistent training in both technology and multilingual pedagogy.

Teachers' Strategies to Encourage Students' Comprehension and Engagement

Teachers in EMI-STEM classrooms apply a variety of strategies to sustain student engagement and improve academic outcomes. Given the dual challenge of understanding both complex STEM concepts and English as the medium of instruction, interactive tasks, real-world applications, and multimodal teaching emerged as the most commonly used methods. According to teachers, these strategies not only enhanced comprehension but also appeared to encourage students to participate more actively in lessons.

To address challenges, teachers reported using a range of differentiation strategies, with translanguaging emerging as a common approach. Many teachers used students' first languages (Kazakh or Russian) to check understanding, provide explanations, or scaffold learning when necessary. "I always mix languages—if students don't understand a concept in English, I explain it in Russian. Otherwise, they lose time trying to decipher the language instead of focusing on the content" (Teacher D, Physics, IB school).

Observations confirmed that teachers frequently switched between English and students' first languages, particularly during complex explanations or when responding to students' questions (Teacher A, Teacher B, Teacher D, Teacher E, Teacher F). In several observed lessons, students themselves initiated translanguaging by asking for clarifications in Kazakh or Russian, after which teachers briefly explained in the requested language before switching back to English.

Another frequently used strategy was simplifying instructional language while maintaining academic terminology. Teachers reported that they often rephrased complex explanations into simpler English but ensured that key subject-specific terms remained unchanged. "I don't translate scientific terms, but I simplify the sentences around them. That way, students focus on learning the new vocabulary while still understanding the concept" (Teacher B, Biology, Tech school). Observations showed that teachers frequently used shorter, more direct sentences, avoided unnecessary lexis, and provided visual aids to support comprehension. For instance, in a biology class, the teacher introduced the term "photosynthesis" and kept the scientific term in English. However, they simplified the surrounding explanation: "Plants make food using light. This process is called photosynthesis" (Observation data, Teacher B, Biology, Tech school, 13.01). Visual aids, like diagrams, helped to provide better explanation, helping students connect the term with its meaning. In another lesson, the teacher avoided complex sentence structures, opting for shorter, clearer instructions like: "First, measure the water. Then, add the salt. Finally, stir" (Observation data, Teacher D, Physics, IB school, 16.01). This allowed students to focus on key content without getting lost in language complexity.

Peer support was also encouraged as a strategy to help students navigate language difficulties. In some classrooms, teachers deliberately paired students with stronger English skills with those who struggled, allowing them to work collaboratively on tasks. "Students learn best from each

other—sometimes they explain things in a way that makes more sense to their peers" (Teacher C, Biology). This was evident in observed group activities, where students frequently assisted each other by paraphrasing instructions or summarizing key points in their first language before switching back to English for discussion.

Translanguaging as Pedagogical and Content Knowledge (PCK)

Teachers across different school contexts demonstrated a generally positive attitude toward translanguaging, recognizing its effectiveness in supporting student comprehension. Teacher-driven translanguaging was widespread. Rather than viewing it as a barrier to English acquisition, teachers strategically used students' first languages (Kazakh or Russian) to scaffold learning, clarify complex concepts, and maintain lesson flow. Teacher A (Physics, STEM school) noted, "I use Russian or Kazakh to clarify and then reinforce in English." While translanguaging helped bridge comprehension gaps, its absence in assessments and policies limited its official application.

Student-driven translanguaging also emerged. Students explained tasks to peers in L1 and translated between languages, fostering peer-to-peer support. Teacher C (Biology, International school) shared, "Sometimes students translate for each other faster than I can." Though widely practiced, translanguaging was not systematized. It functioned as a coping mechanism rather than an endorsed pedagogical strategy.

Technology as Content and Pedagogical Support (TK/CK/TPK)

Technology was used primarily for content delivery. Teachers frequently cited YouTube videos, simulations, and tools like PhET or Kahoot to visualize concepts and make lessons engaging. Yet, these were often used outside classroom instruction or as homework. Teacher D noted, "We rarely have time to integrate simulations into actual lessons." This illustrates the challenge of developing Technological Pedagogical Knowledge (TPK) in EMI contexts.

Apps like Quizlet were popular for vocabulary development. However, digital resources were mostly English-only. Teachers lacked training in how to adapt technology for multilingual learners.

Barriers included limited training, infrastructure issues, and English-only platforms. This led to surface-level tech use, often disconnected from translanguaging goals.

Missed Opportunities for Integrating Translanguaging

Despite the widespread use of technology, the results showed little indication that teachers intentionally combined digital tools and language comprehension. Although some students checked foreign phrases on their own using bilingual dictionaries or online translation apps, this did not take place during teacher-directed teaching. Some teachers allowed students to have quick conversations in their first languages before tasks or summarized English-language video content in Kazakh or Russian, but these activities were not regularly organized or structured around the use of technology.

This suggests a gap in teachers' Technological Pedagogical Knowledge (TPK): while teachers demonstrated competence in selecting tech resources and adapting explanations to students' needs, they lacked the training or frameworks to combine digital tools with multilingual strategies. As a result, EMI-STEM learning is supported by both technology and translanguaging, but they do not reinforce each other, leading to a fragmented instructional approach.

While existing research [7, 10] highlights the passive use of digital tools in EMI settings, this study goes further by identifying a critical gap in the TPACK framework itself—its failure to account for multilingual pedagogical realities. The findings demonstrate that translanguaging operates as an essential form of pedagogical and content knowledge in multilingual EMI-STEM classrooms. As such, this study extends the TPACK model by proposing the explicit integration of translanguaging into its structure, offering a new Multilingual TPACK framework that reflects the dual demands of linguistic and technological mediation in diverse classrooms.

The study's teachers were also concerned that students would become dependent on translation applications, emphasizing word-for-word conversion over conceptual understanding. This underscores the conflict between deeper academic learning and technological convenience [7]. To

bridge this gap, professional development should prioritize training combining translanguaging and technology within TPACK's domains. Teachers could adapt English-only tools like PhET with bilingual annotations or use Padlet for multilingual discussions, enabling lessons that support translanguaging and reduce cognitive load [5]. The Ministry of Education and Science of RK must develop multilingual STEM resources and revise assessments to value translanguaging, aligning with classroom realities for equitable EMI-STEM education.

Recommendations for EMI-STEM Education in Kazakhstan

The main recommendation is a Multilingual TPACK framework integrating translanguaging and technology to bridge their disconnect in EMI-STEM classrooms, enhancing student engagement and comprehension. Phenomenology, focused on understanding the essence of lived experiences [23], was ideal for exploring how EMI-STEM teachers in Kazakhstan's private schools perceive teaching in multilingual classrooms. Unlike surveys, which collect broad but surface-level data, or case studies, which examine specific contexts, phenomenology captures teachers' subjective experiences through in-depth interviews, aligning with the research questions on their experiences and practices (translanguaging and technology use). This method's strength was evident in interviews with six teachers across four schools (STEM, Tech, International, Innovation). For example, Teacher F's use of Kazakh equivalents to teach chemistry revealed how linguistic diversity shapes pedagogical choices, a nuance that quantitative methods might overlook. This depth informed the study's findings, such as the disconnect between translanguaging and technology, guiding a framework that leverages teachers' experiential knowledge.

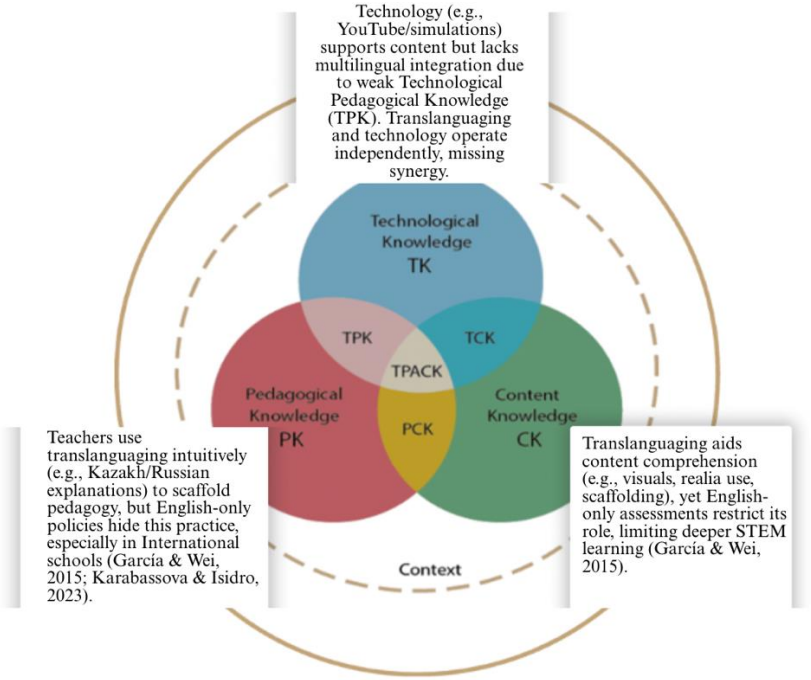

Figure 3 - Multilingual TPACK Framework for EMI-STEM Education

Note. The Multilingual TPACK Framework, developed for this study to integrate translanguaging (PK/PCK) and technology (TK/CK) in EMI-STEM education, extends Koehler et al. [21] to address multilingual support gaps

Figure 3 shows translanguaging (PK/PCK) and technology (TK/CK) operating separately, limiting multilingual support. Intuitive translanguaging (e.g., Kazakh explanations) is obscured by English-only policies [6], while assessments restrict comprehension [5]. Technology's content

support (e.g., PhET) lacks TPK for multilingual integration [24], necessitating a framework for synergy.

To integrate translanguaging and technology in Kazakhstan's EMI-STEM classrooms, the Ministry of Education should recognize translanguaging as a valid strategy, implementing a framework guiding L1 use (e.g., Kazakh, Russian) to support STEM mastery and English proficiency [5]. This framework should include bilingual materials like glossaries and lab instructions to reduce cognitive load, allow L1 in formative assessments (e.g., oral explanations) while maintaining English summative outputs, and launch pilot programs to test bilingual strategies, informing national reforms [16]. Additionally, developing multilingual resources, such as PhET simulations with Kazakh/Russian annotations and collaborative platforms like Padlet, can enhance CK and PCK, addressing resource scarcity [5, 23]. Furthermore, ongoing, context-specific training within TPACK should move beyond trial-and-error, focusing on designing multilingual lessons with digital tools (e.g., translation apps, videos, gamified apps), adapting English-only tools with bilingual prompts, and using "translanguaging moments" (e.g., L1 clarifications) to scaffold learning, extending TPACK to address linguistic diversity [5, 9, 25].

Building on this framework, the following recommendations address policy, infrastructure, and teacher development to integrate translanguaging and technology, aligning with TPACK and findings. The Table 1 below outlines the proposed framework, detailing strategies for integrating translanguaging in EMI-STEM classrooms. Each component aligns with TPACK domains to ensure cohesive implementation.

Table 1 - Translanguaging Integrated Framework

Component	Description	TPACK	Strategies
Multilingual Resource Development	Create and improve STEM materials in English and students' L1 (e.g., Kazakh, Russian).	Technological Knowledge (TK) + Content Knowledge (CK)	- Develop bilingual glossaries for key STEM terms. - Adapt platforms like PhET simulations with L1 subtitles or annotations. - Partner with ed-tech providers to produce multilingual content.
Structured L1 Use Guidelines	Define when and how to use L1 to scaffold comprehension without undermining English goals.	Pedagogical Knowledge (PK) + Translanguaging Knowledge	- Use L1 for initial concept explanation, transitioning to English for reinforcement. - Encourage L1 discussions in group activities, followed by English summaries. - Implement "translanguaging moments" (e.g., 10-minute L1 clarifications).
Technology-Enhanced Translanguaging	Leverage digital tools to support multilingual learning interactively.	TK + PK + Translanguaging Knowledge	- Use collaborative platforms like Padlet for students to post questions in L1 and English, with teachers providing bilingual feedback to scaffold STEM concepts." - Use gamified apps with bilingual prompts to engage students.
Multilingual assessment	Design assessments that value multilingual processes while prioritizing English outputs.	PK + CK + Translanguaging Knowledge	- Allow L1 planning in formative assessments, with final submissions in English. - Use bilingual rubrics to evaluate content and language progress. - Incorporate oral assessments to capture translanguaging fluency.

Note. The Translanguaging Integrated Framework, informed by study findings and Koehler et al. [21], proposes TPACK-aligned strategies for multilingual EMI-STEM classrooms.

Kazakhstan's EMI-STEM policies prioritize English proficiency, often neglecting multilingual resources that enhance STEM understanding and English development [5]. Teachers intuitively use translanguaging (e.g., Kazakh explanations) and technology but lack training to integrate them cohesively, relying on trial-and-error. To address this, professional development should embed translanguaging within TPACK, offering ongoing, context-specific training on designing multilingual lessons with digital tools (e.g., translation apps, Padlet), balancing content and English goals, and adapting tools like PhET with bilingual annotations [9, 24]. TPACK's limitation in not addressing linguistic diversity requires extending it to guide L1 use in digital pedagogies, preventing English-centric marginalization [5]. The Ministry of Education should incorporate bilingual materials (e.g., glossaries, lab instructions) and allow L1 in formative assessments (e.g., simplifying languages, definitions or translations) to reduce cognitive load while maintaining English summative outputs. Structured training with guidebooks and model lessons, plus pilot programs testing bilingual strategies, can inform inclusive reforms, ensuring translanguaging supports equitable STEM education [16]. These strategies, detailed in Table 1, align with Multilingual TPACK for student-centered learning.

Conclusion

This study explored how EMI-STEM teachers in Kazakhstani private secondary schools perceive and implement translanguaging and technology in multilingual classrooms. Through a phenomenological approach, it uncovered how these strategies are used to support student comprehension and engagement, but often in parallel rather than as part of a unified pedagogical model. Translanguaging emerged as a practical and widely accepted method for scaffolding understanding, particularly when learners struggled with English-medium STEM content. However, its informal status and absence from policy and assessments limited its full potential. Technology, while frequently used to enhance instruction and visualize abstract concepts, was similarly constrained—used more for content delivery than for linguistic or interactive support.

A key contribution of this study is the development of the Multilingual TPACK framework, which explicitly integrates translanguaging into the domains of pedagogical and content knowledge. By doing so, the framework acknowledges the multilingual realities of EMI-STEM classrooms and highlights the need to align instructional strategies with students' linguistic repertoires. Findings show that while teachers intuitively blend language support and technology, their practices remain fragmented due to policy silence, limited training, and the absence of structured tools for integration.

This study recommends that policymakers recognize translanguaging as a legitimate instructional approach and embed it into teacher training, curriculum materials, and assessment design. Technology tools should be adapted or developed to support multilingual learning environments, ensuring inclusivity and cognitive accessibility. Future professional development should focus on helping teachers design integrated lessons that draw on both translanguaging and digital tools within a TPACK framework. In doing so, Kazakhstan's EMI-STEM education can evolve into a more inclusive, equitable, and effective system—better aligned with the multilingual realities of its learners.

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ҚАЗАҚСТАНДЫҚ ОРТА МЕКТЕПТЕРДЕ АҒЫЛШЫН ТІЛІНДЕ ОҚЫТАТЫН STEM-СЫНЫПТАРДА МҰҒАЛІМДЕРДІҢ ТРАНСЛИНГВИЗМ МЕН ТЕХНОЛОГИЯЛАРДЫ ПАЙДАЛАНУЫН ҚАБЫЛДАУЫН ЗЕРТТЕУ

Бұл зерттеу Қазақстан мектептерінде ағылшын тілінде жаратылыстану-ғылыми цикл пәндерін (EMI-STEM) оқытудағы транслингвизм мен технологиялардың рөлін қарастырады. Көптілді педагогиканы қосу арқылы кеңейтілген TPACK (Технологиялық-педагогикалық-мазмұндық білімдер) моделіне сүйене отырып, зерттеу осы стратегиялардың оқушылардың сабақта қатысуы мен түсінуін қалай қолдайтынын зерттейді. Феноменологиялық тәсілді пайдалана отырып, деректер Астананың төрт жекеменшік мектебінде алты мұғаліммен сұхбат және сабақ бақылау арқылы жиналды. Нәтижелер көрсеткендей, мұғалімдер STEM мазмұнын бекіту және оқушылардың түсінігін қолдау үшін басқа тілге аударуға жиі жүгінгенімен, бұл тәжірибе әлі де бейресми болып қалуда және білім беру саясаты мен бағалау жүйесінде көрініс таппайды, олар әлі де бір тілді болып қала береді. Технологиялар мазмұнды жеткізу мен оқушылардың қызығушылығын арттыру үшін кеңінен қолданылғанымен, олар көптілді оқыту тәжірибесімен сирек ұштасады. Бұл құралдарды бөлу олардың инклюзивті және тиімді оқытуды ынталандыру тұрғысынан әлеуетін шектейді. Зерттеу көп тілді TPACK құрылымын ұсынады және EMI-STEM контекстінде басқа тілдерге аударманы цифрлық құралдармен біріктіру үшін кәсіби даму мен саясаттағы өзгерістерді ұсынады.

Түйін сөздер: EMI, STEM, транслингвизм, көптілді білім, TPACK моделі, Білім берудегі технологиялар.

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ИЗУЧЕНИЕ ВОСПРИЯТИЯ УЧИТЕЛЯМИ ИСПОЛЬЗОВАНИЯ ТРАНСЛИНГВИЗМА И ТЕХНОЛОГИЙ В STEM-КЛАССАХ С ПРЕПОДАВАНИЕМ НА АНГЛИЙСКОМ ЯЗЫКЕ В СРЕДНИХ ШКОЛАХ КАЗАХСТАНА

Данное исследование рассматривает роль транслингвизма и технологий в преподавании предметов естественно-научного цикла на английском языке (EMI-STEM) в школах Казахстана. Применяя расширенную модель TPACK**,** (Модель технологическо-педагогическо-содержательных знаний), включающую многоязычную педагогику, оно исследует, как эти подходы влияют на вовлеченность и обучение учащихся. Используя феноменологический подход, данные были собраны посредством интервью и наблюдений с шестью учителями в четырех частных школах Астаны.

Полученные результаты показывают, что, хотя учителя часто полагаются на перевод на другой язык для закрепления содержания STEM и поддержки понимания учащимися, эта практика остается неформальной и не отражается в образовательной политике и оценивании, которые по-прежнему остаются в основном одноязычными. Технологии широко используются для поддержки предоставления контента и вовлечения студентов, но они редко сочетаются с практикой многоязычного обучения. Разделение этих инструментов ограничивает их потенциал в плане содействия инклюзивному и эффективному обучению. В исследовании предлагается многоязычная структура TPACK и даются рекомендации по изменению профессионального развития учителей и образовательной политики для интеграции транслингвизма с цифровыми инструментами в контексте EMI-STEM.

Ключевые слова: EMI, STEM, транслингвизм, многоязычное образование, модель TPACK, технологии в образовании.

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