Exploring SFL to Understand Kazakhstani Teachers Translanguaging Practices in Mathematics (STEM) Classrooms

Assylzhan Ospanbek

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Ethics Approval

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7 November 2020

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This letter now confirms that your research project entitled: **Exploring Kazakhstani science teachers' translanguaging practices through a Systemic Functional Linguistics lens** has been approved by the Graduate School of Education Ethics Committee of Nazarbayev University.

You may proceed with contacting your preferred research site and commencing your participant recruitment strategy.

Yours sincerely

Dr Michelle Bedeker

On behalf of Zumrad Kataeva
Chair of the GSE Ethics Committee
Assistant Professor
Graduate School of Education
Nazarbayev University

Block C3, Room 5006
Office: +7 (7172) 70 9371
Mobile: +7 777 1929961
email: zumrad.kataeva@nu.edu.kz

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Abstract

Exploring SFL to Understand Kazakhstani Teacher's Translanguaging Practices in Mathematics (STEM) Classrooms

Translanguaging has been a research topic of interest for several decades amongst scholars advocating for multilingualism as a resource. Therefore, the purpose of this study is to explore systemic functional linguistics (SFL) to understand Kazakhstani teachers' translanguaging practices in mathematics (STEM) classrooms. To shed light on their translanguaging practices, the following questions underpinned the study: 1) How do math teachers' metalinguistic knowledge impact their translanguaging practices in two classrooms?; 2) What is the metalinguistic knowledge that mathematics teachers need to draw on translanguaging as a pedagogical tool?; 3) When and why do math teachers switch languages?; and 4) How do these language switches contribute to the scaffolding of content and language? This qualitative study was based on Halliday's SFL framework and used triangulation of data such as a questionnaire, document analysis, and interviews. The participants were two NIS mathematics teachers who have been teaching for two to five years. The findings revealed that in transformative translanguaging practices, teachers should know different mathematics genres such as explanations, procedures/instructions, and information reports. Next, the study showed that teachers in this particular context translanguage because of their students' needs. Lastly, the study illustrated that teachers' translanguaging practices were content-driven. As a result, there was minimum space for scaffolding math registers, multiliteracies, and mathematics metalanguage. The research recommends that future professional development projects focus on developing STEM teachers' metalinguistic knowledge about their discipline and subject-specific literacies to open up transformative translanguaging practices inclusive of content and language.

Key terms: genre, mathematical register, metalinguistic knowledge, translanguaging, field, tenor, mode.

Аңдатпа

Қазақстандық Мұғалімдерінің Математика (STEM) Сыныптарындағы Транстілдесу Тілдік Практикасын Түсіну үшін Жүйелік Функционалды Лингвистиканы Зерттеу

Бірнеше онжылдықтар бойында транстілдесу көптілділікті ресурс ретінде қабылдайтын ғалымдарды қызықтыратын зерттеу нысаны болып келді. Сәйкесінше, бұл зерттеудің мақсаты - математика сабағында (STEM) Қазақстандық мұғалімдердің транстілдесу практикасы тұжырымдамасы үшін жүйелік функционалды лингвистиканы (ЖФЛ) зерттеу. Осы мақсатқа жету барысында "математика мұғалімдерінің металингвистикалық білімдері олардың сыныптағы транстілдесу практикасына қалай әсер етеді?" деген сұрақ қойылды. Негізгі сұраққа қоса, төмендегі үш қосалқы сұрақ қолданылды: Транстілдесуді педагогикалық құрал ретінде пайдалану үшін математика мұғалімдеріне қандай металингвистикалық білім қажет болады?; Жаратылыстану пәні мұғалімдері қашан және не себептен басқа тілге ауысады?; Бұл тілдік практикалар пән мен тілдің дамуына қалай ықпал етеді? Бұл сапалы зерттеу сауалнамасы, құжаттарды талдау және сұхбат түрінде мәліметтер триангуляциясын қолданып, Халлидейдің ЖФЛ теориясына негізделді. Зерттеуге қатысушылар мектепте екі жылдан бес жылға дейін сабақ беру тәжірибесі бар математика пәнінің екі мұғалімі болды. Зерттеу нәтижелері трансформативті тілдік тәжірибені қолдану үшін мұғалімдердің процедуралар/нұсқаулықтар және ақпараттық жанрлар сияқты әр түрлі жанрларды жақсы білуі керек екенін көрсетті. Оған қоса, бұл тұрғыда мұғалімдер өз оқушыларының қажеттіліктеріне байланысты транстілдесуді қолдана алады. Сонымен қатар, зерттеу нәтижесі мұғалімдердің аударма практикасы тек пәнді дамытуға бағытталғандығын

көрсетті. Осылайша, математикалық регистрлер мен метатілді қолданудың минималды кеңістігі бар екені анықталды. Зерттеу мұғалімдердің өз пәндері бойынша (STEM) метатілдік білімдерін дамыту үшін біліктілікті арттыру (БА) бағдарламаларынан өту мүмкіндігін қарастыру керектігін ұсынады. Және де, жанрға негізделген бағдарламалардың математика мұғалімдерін қажетті метатілдік біліммен және пәндік сауаттылықпен қалай жабдықтайтындығын да зерттеу қажет.

Негізгі терминдер: жанр, математикалық регистр, металингвистикалық білім, транстілдесу, филд, тенор, моуд.

Аннотация

Изучение Системно Функциональной Лингвистики для Понятия Практики Трансязычие Казахстанских Учителей в Классах Математики (STEM)

На протяжении нескольких десятилетий трансязычие было предметом исследования, представлявшим интерес для ученых которые воспринимали многоязычие как ресурс. Таким образом, цель данного исследования – применить Системную Функциональную Лингвистику (СФЛ) для осмысления практики трансязычия Казахстанских учителей на уроках естественных наук, таких как математика (STEM). Для этой цели исследование ставит следующий вопрос: Как металингвистические знания учителей математики влияют на их практику трансязычие в контексте двух классов? Кроме того, было сопоставлено три под вопроса: 1. Какие металингвистические знания потребуются учителям математики чтобы использовать трансязычие в качестве педагогического инструмента? 2. Когда и почему учителя естественных наук переходят на другой язык? 3. Как эти языковые смены способствуют раскрытию содержания и языка? Данное исследование качественного типа было основано на СФЛ Халлидея и использовало триангуляцию данных в виде анкеты, анализа документов и интервью. Участниками исследования были два преподавателя математики из НИШ, которые преподают в данной школе от двух до пяти лет. Результаты исследования показали, что для использования трансформативной трансязычной практики учителя должны быть ознакомлены с различными жанрами, такими как процедуры/инструкции и информационные отчеты. Далее, исследование показало, что в данном контексте учителя используют трансязычие опираясь на потребностями своих учеников. И, наконец, исследование показало, что переводческая практика учителей

ориентирована только на содержание контента; таким образом, существует минимальное пространство для использования математических регистров и метаязыка. Исследование предполагает, что следует рассмотреть возможность проведения повышение квалификаций (ПК) по развитию метаязыковых знаний преподавателей по их дисциплинам (STEM). Кроме того, необходимо изучить, как программы, основанные на жанрах, могут поддержать учителей математики необходимыми метаязыковыми знаниями и предметной грамотностью.

Ключевые термины: жанр, математический регистр, металингвистические знания, трансязычие, филд, тенор, моуд.

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Chapter 1: Introduction

Migration and population flows have become a global norm that has resulted in linguistic contact, creating conditions where successful integration requires proficiency in a new country's language (Esser, 2006). Such transnational and international flows blur linguistic boundaries, with clear ramifications for education because homogenous school spaces have become multicultural and heterogeneous. Therefore, a central issue in multilingual education research is to consider the ability of schools and teachers to cope with linguistic diversity (Probyn, 2009, 2015). In addition, the hegemony of English as a global language has resulted in an increased interest in English as a subject and as a medium of instruction (Goodman et al., 2020). Interestingly, English as a medium of instruction (EMI) is beginning to take hold in post-Soviet countries like Kazakhstan, where governments have adopted multilingual and trilingual education policies. As a result, globalization processes have increased English's value in Kazakh education (MOES, 2015).

In Kazakhstan, the trilingual education policy stipulates the Kazakh, Russian, and English languages usage in schools (Landau & Kellner-Heinkele 2012, as cited in Bahry et al., 2017). For instance, teaching through English is now a requirement for science, technology, engineering, and mathematics (STEM) subjects. However, as Syzdykbayeva (2017) highlights, it is worrying that there is a lack of research on how the trilingual educational reform will be implemented and developed in Kazakhstan. In addition, teachers are now adopting a content and language integrated (CLIL) approach through EMI placing disciplinary and linguistic demands at the center (Karabassova, 2020). While these policy changes are commendable, teachers' home language and previously teaching STEM content through either Kazakh or Russian hold unintended consequences for CLIL pedagogy. Since STEM teachers

are now required to make substantial shifts in their pedagogy, this research has had as a focus the pedagogy of such teachers and how their EMI classroom contexts might result in their shifting between languages, a term coined as translanguaging in the literature (Garcia & Wei, 2014).

Current research on the use of translanguaging in the Kazakhstani context has focused on teachers' beliefs and their perspectives associated with the home language (L1) role in EMI classes. For example, a study investigating pre-service education students' beliefs on translanguaging found that they considered translanguaging a resource; however, the majority preferred the maximum use of English (Tastanbek, 2019). Similarly, a comparative study about the role of the Kazakh, Russian and English medium of instruction illustrated that even though teachers preferred using one language, translanguaging in the classroom was inevitable because both teachers and their students switched to the L1 for meaning-making (Amaniyazova, 2020). Moreover, Alzhanova (2020) explored EMI content teachers' translanguaging perspectives and found that they preferred the Russian and English languages because they viewed Kazakh as not required in education. Finally, Abdrakhmanova (2017) explored teachers' and students' perceptions of using their L1 in English language and science classes. This study showed that despite teachers' monolingual language teaching preference, they used translanguaging to check their students' understanding of the topic, give examples, and elaborate on technical and new vocabulary.

However, what is not yet evident in the Kazakhstani research literature is the implementation of translanguaging as an intentional pedagogical tool where language support is a planned and scaffolded teaching strategy (Probyn, 2019). Another gap relates to how STEM teachers' L1 metalinguistic knowledge impacts their translanguaging practices in CLIL classes. Moreover, none of the studies to date has drawn on a linguistically-informed theory to

shed light on what is needed to effectively use translanguaging as a pedagogical tool (Harman, 2018). Consequently, this study focused on two STEM teachers in the mathematics discipline to explore their L1 metalinguistic knowledge of mathematics and how this contributes to translanguaging pedagogy in their CLIL classes.

1.1. Statement of the Problem

Globally, debates about EMI in CLIL classes are often complex and contested (Floris, 2014). This complexity is emerging in the Kazakh educational context because trilingual education has resulted in EMI adoption for STEM subjects (Zharkynbekova et al., 2013). While this switch is commendable, STEM teachers' home language and experience of teaching through either Kazakh or Russian now mean that they must make a considerable linguistic shift to English, a foreign language for both them and their students. Therefore, this thesis has focused on EMI in two CLIL classes to illustrate how teachers and learners shift between languages during math lessons. As a result, this research intended to shed light on the translanguaging practices in two mathematics classrooms because translanguaging can contribute to a deep understanding of content and promote language development (Garcia & Wei, 2014, p. 64).

1.2. Purpose of the Study

The purpose of this study was to investigate STEM teachers' metalinguistic knowledge of mathematics and how it impacts EMI instruction and translanguaging practices in two Grade 10 Classes. This study has drawn on a Systemic Functional Linguistics (SFL) lens to investigate teachers' translanguaging practices in two CLIL classrooms to understand how language is used in these mathematics classrooms. For this reason, the participants were two math teachers from one Nazarbayev Intellectual School (NIS) who displayed the following

characteristics:(a) have more than two years of experience teaching mathematics through EMI; (b) being a native speaker of the Russian and/or Kazakh languages. It was anticipated that these participants could provide rich data on implementing EMI and translanguaging practices in this context.

1.3. Research Question

To shed light on the impact of EMI in two math classes, the underpinning research question and sub-questions of this study are:

How does math teachers' metalinguistic knowledge impact their translanguaging practices in two classrooms?

- What are the metalinguistic knowledge that mathematics teachers would need to draw on translanguaging as a pedagogical tool?
- When and why do math teachers switch languages during EMI instruction?
-How do these language switches contribute to the scaffolding of content and language?

1.4. The Rationale and Significance of the Study

This study is significant for several reasons. First, it contributes to the current literature associated with translanguaging as a pedagogical tool in EMI contexts. However, where previous studies in Kazakhstan focused on teachers' beliefs and perceptions, this study focuses on math pedagogy in EMI contexts (Abdrakhmanova, 2017; Alzhanova, 2020; Amaniyazova, 2020; Tastanbek, 2019;). Another significance of this study is that it sheds light on the metalinguistic knowledge associated with mathematics and the consequent implications for translanguaging. Furthermore, the SFL framework that draws on *Field, Tenor, and Mode* foregrounded the genres, linguistic features, and registers necessary for mathematics pedagogy

in EMI contexts because teachers and learners are "learning a language, learning through language, learning about language" (Halliday, 1993, p. 113). Finally, the study also sheds light on how mathematics registers and disciplinary literacies can inform pre-service teacher training and future professional development programs.

1.5. Definitions of Key Terms

Genre is defined "as staged, goal-oriented social processes. Staged, because it usually takes us more than one step to reach our goals; goal-oriented because we feel frustrated if we don't accomplish the final steps; social because writers shape their texts for readers of particular kinds" (Martin & Rose, 2008, p. 6)

A mathematic register is "a set of meanings appropriate to a particular function of language, together with the words and structures that express these meanings" (Schleppegrell, 2010, p.46).

Metalinguistic knowledge is explicit knowledge about the language features and how they are used (Enns, 2017).

Translanguaging as a pedagogical tool and a pre-planned proactive approach provides "safe spaces for students to adopt their multilingual repertoire for learning purposes" (Canagarajah, 2011, p. 8 as cited in Anwaruddin, 2018).

The field foregrounds the content of a topic visible in the participants, circumstances, and processes that helps us to understand the who, where, and how. For example, when people use particular lexico-grammatical features such as mental verbs and elements of cohesion,

these are ideational metafunctions that allow us to understand what is occurring in the text (Nagao, 2019, p. 2).

Tenor is how people use language to build relationships with others (Schulze, 2015). Language users make different language choices to connect with others, show affinity toward something, and negotiate power relationships (p. 114).

Mode refers to the method language users choose to share information and organize text or content to make meaning (Schulze, 2015).

1.6. Chapter Outline

This thesis consists of five chapters. First, this introduction chapter provides insights into the context and background associated with translanguaging in CLIL classrooms. It also covers the purpose and significance of the study and the research questions that have guided this project. Then, Chapter Two, the literature review section, introduces the existing literature on translanguaging, research studies that link translanguaging with SFL, and finally foregrounds SFL research studies in education. The third chapter, the methodology section, focuses on qualitative research as a method, the research tools and the data analysis frame that underpins the study, and most importantly, the ethical considerations that underpin the research project. Chapter Four presents the data, the data analysis, and a discussion of the findings revealed from the data. Lastly, Chapter Five, the conclusion chapter, summarizes the research findings, provides recommendations and situates the limitations of the project.

Chapter 2: Literature Review

Chapter One introduced the problem statement, significance, and research questions associated with translanguaging in the Kazakhstani context. This chapter foregrounds the theoretical and conceptual underpinnings that guide this project's research problem and analytical framing. First, in section 2.1, I present conceptualizations and definitions of translanguaging and trace its historical roots and development. Following this, I explore translanguaging practices in contexts such as the United States (US), South Africa, the United Kingdom (UK), and Kazakhstan. Here, I also review research studies that have combined translanguaging with an SFL framework. Secondly, in Section 2.2, I introduce SFL as a functional language theory, then present research studies highlighting the use of SFL in content-based pedagogy, mathematical disciplinary knowledge, and professional development. In Section 2.3, I briefly illustrate some critiques against the SFL theory and conclude with the advantages the use of SFL holds for my research project.

2.1. Translanguaging

In the last decade, there has been a growing interest in students' L1 and how their multilingual repertoires can be a resource in language teaching (Creese & Blackledge, 2010; Garcia, 2009; Garcia & Wei, 2014; Garcia & Lin, 2016). For instance, Creese and Blackledge (2010) showed that students' L1 fosters translanguaging practices that provide "an avenue for the reproduction of social, community, and pedagogic values and goals" (p.112). Garcia and Wei (2014) argue that multilingual speakers draw on their linguistic repertoires in various social spaces when they confront a complex variety of spoken languages. Therefore, the researchers oppose monolingualism and argue for students' linguistic repertoires as resources to facilitate meaning-making. For this reason, the literature shows a shift from concepts such

as code-switching and code-mixing towards the use of translanguaging as a pedagogical tool in contexts such as Europe, Africa, and the US (Hornberger & Link, 2012; Nikula & Moore, 2016; Probyn, 2019). However, because translanguaging is used as a theoretical frame in research and conceptualized as a resource that can guide pedagogy, it is a complex and often contested term (Leung & Valdes, 2019). As a result, it is necessary to provide some background to the historical roots of translanguaging.

2.1.1. Tracing the Historical Roots of Translanguaging

The notion of translanguaging first emerged in 1980 in Northern Wales when the dominance of English resulted in fears about the Welsh language being endangered or threatened (Lewis et al., 2012). In this context, Cen Williams purposefully used both the Welsh and English languages in the classroom and illustrated how they offered a linguistic bridge that facilitated the understanding of both subject content and learners' proficiency in the two languages (Baker, 2001). For instance, in the Welsh context, reading in the classroom was done in English, and then students' L1 (Welsh) was used for oral or for the completion of writing tasks. Therefore, using two languages in the classroom, even though not termed translanguaging, supported the minority language and helped learners maintain their native language. This means that sound knowledge of two languages and a languaging pedagogy hold advantages when classroom input and output acknowledge the various linguistic repertoires of learners (Baker & Wright, 2017). Since then, the effectiveness of switching languages in the classroom has become a firm argument for those who view multilingualism as a resource (Creese & Blackledge, 2010; Garcia, 2009).

In multilingual research, the term code-switching emerged as a lens to show language contact in multilingual contexts, resulting in users alternating between two or more languages

in a conversation. The definitions illustrated that code-switching is "a switch from one language code to another that rests on the assumption that bilinguals have two separate, bounded language systems" (Garcia & Kleifgen, 2018, p. 89). In addition, Brice (2000) highlighted that "code-switching can serve specific classroom functions, that is, as linguistic markers to indicate topic shifts providing translations or giving word substitutions instead of giving a full definition" (p.21). Therefore, code-switching in the classroom highlights the way shifts in various language codes can also be used as tools to overcome language barriers in classrooms. However, Garcia (2014) argues that codes-witching only focuses on "a shift or a shuttle between two languages" and offered the term translanguaging as an alternative because it treats language practices of multilingual people as flexible and fluid (p. 22).

Garcia (2009) put forward the concept of translanguaging when researching Latino students' language practices in the USA. The results of this research illustrated that translanguaging is not centered only on the language but also on multilinguals' multiple discursive practices that allow them to make sense of their multilingual world. Furthermore, translanguaging is a naturally occurring instinct or response of bilingual and multilingual speakers, making their translanguaging practices inseparable from their being (Garcia & Wei, 2014). Consequently, in the past two decades, translanguaging has been a robust term in research projects because it defies previous assumptions about languages as separate entities; thus, it represents flexibility, multimodality, and heterogeneity in language pedagogy.

Interestingly, the notion of translanguaging as a pedagogical tool has gained prominence in the research literature associated with classroom pedagogy (Cenoz & Gorter, 2017). On this point, Wei (2017) states that it can form the foundations of effective "pedagogical practice" (p.7) and argues for the reconsideration of the role of the L1 in second

and foreign language learning. Therefore, translanguaging is not only about shifts in language practices, but it offers a transformative and re-semiotization process that can facilitate the use of languages for creative and critical co-construction of knowledge. For example, research highlights how people utilize their native languages in Singaporean and New Chinglish communication to create a new type of speech that transformed the English language (Wei, 2017).

However, Canagarajah (2011) points out that teachers unconsciously apply translanguaging practices; thus, it is not an intentional pedagogical strategy. For this reason, research that foregrounds the use of translanguaging as a pedagogical tool might not draw on semiotic mediation, zone of proximal development, and Bernsteinian concepts of visible and invisible pedagogies (see Christie, 2005 for an overview). Therefore, translanguaging as a pedagogy needs to make explicit the didactic and pedagogical notions of the subject content. In fact, Canagarajah (2011) argues that "The pedagogical side is underdeveloped in general" (p.8). Consequently, it is necessary to shed light on the use of translanguaging in school contexts.

2.1.2. Translanguaging in School Contexts

In the US context, Hornberger and Link (2012) argue that it is essential to recognize that translanguaging and transnational literacies create new spaces that value students and their families' multilingual repertoires. They state that despite the growth in immigrant student populations, the No Child Left Behind Policy does not consider changing demographics. Their research highlights that even though bilingual and two-way immersion schools promote good quality education, high-stakes testing practices value monolingual ideologies. For example, it promotes educational success to local citizens whose first language is English while denying

epistemic access associated with the multilingual repertoires of L2 students. As a result, denying such knowledge can be especially detrimental in content subjects if the multilingual repertoires of learners do not count as a resource towards the scaffolding of language and content.

In different European countries, there has been a growing body of research on integrating language and content. This research includes bilingual content teaching, bilingual subject teaching, and content-based language teaching, and these most often appear under the umbrella of Content and Language Integrated Learning (CLIL) (Cammarata & Haley, 2018; Cenoz et al., 2013). CLIL draws on a dual-focused approach where content subjects infuse language learning (Cenoz et al., 2013, Dearden, 2015). As a result, translanguaging in this context acknowledges students' L1 and incorporates their linguistic repertoires into flexible learning processes because it draws on both the foreign language and mother tongue in CLIL classes

In the UK, research conducted in a Gujarati and Chinese community language school revealed that teachers and students used flexible language practices, hence questioning the monolingual assumptions of bilingual schools and demonstrating the importance of translanguaging (Creese & Blackledge, 2010). In this study, teachers were using translanguaging to engage their students in conversation and classroom activities. The findings illustrated that translanguaging opened up space for students to become active participants rather than passive listeners. Also, both teachers and students used whatever "signs and forms" helped create new forms of communication (p.112). As a result, this research pointed towards translanguaging as incorporating multilingual learners' whole linguistic repertoire, which offered more significant meaning-making potential in EMI contexts. However, the extent that

translanguaging made visible the elaborate and restricted codes needed for successful academic performance was underexplored (Bernstein, 2003).

Translanguaging has also impacted post-colonial contexts, such as in Africa, where many countries have maintained the former colonizer's language as the official language in education (Heugh, 2015; Pluddemann, 2015). In South Africa, Probyn (2019) demonstrated the challenges connected with post-colonial ideologies and the hegemony of the English language at one rural school where learners have to switch to English as a medium of instruction (MOI), regardless of their level of proficiency in this language. This case study research in one eighth-grade science classroom revealed that one teacher who used the isiXhosa and English languages in the science classroom offered learners more opportunities to learn science than those who preferred to use English only. Thus, the findings show that switching to English MOI negatively impacted those studying in their native African and other languages. Interestingly, the study also highlighted that teachers used students' L1 to bridge science assessments in English.

Research studies illustrate the advantages of using students' full linguistic repertoires in Hong Kong CLIL classrooms in Asia. For example, Lin and He (2017) showed how translanguaging informed pedagogical practices had positive implications for affirming Grade Nine Pakistani, Nepalese, and Indian minority students' identities. In addition, it showed how one teacher whose linguistic knowledge differed from her students' opened up a meaning-making space in the CLIL classroom because the students' home languages served as a resource in pedagogical scaffolding of the content. Translanguaging was the primary pedagogical strategy to scaffold biology content; it allowed students to use their L1 and highlight content-specific words important in understanding the lesson. The results shed light

on how translanguaging contributed towards the students' meaning-making when they switched between languages to understand the complex content of a biology lesson.

In the Kazakhstani schools, the medium of English for science subjects underpins science, technology, engineering, and math (STEM) subjects. To become globally competitive, Kazakhstan switched to a trilingual education policy in 2017, which mandated EMI in STEM classes from Grade Five in experimental schools (MoES, 2015; Zhilbayev et al., 2019). However, research highlights teachers' limited English language proficiency, their misperceptions of CLIL, and Kazakh students' ability to comprehend STEM content in a foreign language (Karabassova, 2020). In fact, the international literature highlights that teachers' limited subject literacies can result in challenges with integrating both language and content and a stronger preference for focusing on content in CLIL classes (Koopman et al., 2014; San Isidro, 2019).

Interestingly, CLIL researchers have advocated Systemic Functional Linguistics (SFL) in CLIL classrooms to improve teachers' subject literacies, enhancing their pedagogical ability to develop language and content (Llinares & McCabe, 2020; Morton, 2010). SFL views languages as a semiotic resource explaining how language is used and structured in content subjects (Forey, 2020; Llinares & McCabe, 2020; Morton, 2010). Therefore, the relevance of SFL in CLIL pedagogy needs attention because it offers a linguistic framework that connects language use in its socio-cultural contexts and provides a metalanguage to speak about language use in STEM subjects. As a result, SFL can offer linguistic resources for translanguaging pedagogies.

2.1.3. Translanguaging and SFL

SFL theory gives centrality to plurilingualism and translanguaging because learners' linguistic repertoires function as resources to scaffold discipline-specific methods of knowledge construction (Harman & Khote, 2018). This plurilingual underpinning can empower both teachers and learners because it considers learners' cultural and linguistic backgrounds as resources for scientific sense-making; thus translanguaging is, "both a 'social and cognitive activity" (Garcia & Wei, 2013, p. 40). Therefore, when drawing on SFL: 1) STEM teachers can situate mathematic language in social and cultural contexts; 2) they can offer their learners access to the powerful metalinguistic knowledge of STEM discourses. For example, in CLIL classrooms, teachers can use translanguaging to make explicit how nouns, verbs, and other subject-related terms signal the topic or its content. They can use a metalanguage associated with STEM grammatical choices to foreground disciplinary literacies in STEM classes.

In South Africa, Heugh (2015) draws attention to the connection between translanguaging and genre-based pedagogy in multilingual contexts. She argues that purposefully integrating translanguaging and genre-based pedagogy can serve as explicit pedagogy for engaging students in productive learning processes. For example, she argues that if students are explicitly inducted into the STEM genres using their linguistic repertoires to make sense of disciplinary literacies, translanguaging will bridge "epistemological access between the everyday world of local contexts and scientific knowledge the school curriculum" (p.280). Also, Probyn (2014) has demonstrated how teachers can use translanguaging as "bridging discourse" across modes, allowing students to get an opportunity to learn science.

Similarly, in the US, Harman, and Khote (2017) researched how the sustained use of SFL and translanguaging can challenge the deficit positioning of 10th Grade bilingual students. The study focused on how translanguaging pedagogy allowed for movement between students'

mother tongue and academic registers within the EMI classroom. The study found that SFL can support bilingual students in interpreting, using, and embodying rich cultural repertoires in their everyday lives to scaffold academic discourses. As a result, an SFL frame can make visible the restricted codes through translanguaging as a pedagogical tool because "educational failure is linguistic failure" (Bernstein, as cited in Walker, 2010).

2.2. SFL as Theory and Analytical Frame

Halliday, who developed Systemic Functional Linguistics (SFL), views language as a semiotic resource, emphasizing that language has a purpose, is context-dependent, and functions as a meaning-making resource (Halliday, 1993; Harman, 2018). SFL originated in the Australian context as part of the Disadvantaged Schools Program (DSP) that focused on developing teachers' metalinguistic skills (Cope & Kalantzis, 1993). The DSP focused on the metalinguistic knowledge of the genres, especially developing students' understanding of school genres (Gebhard & Harman, 2011 p. 49). In addition, SFL genre-based pedagogy has influenced teachers' professional development programs dating back to the 1990s, resulting in linguistically-informed testing criteria known as "scaling," which now guide the current national Australian English curriculum (White et al., 2014). For more than three decades, SFL researchers have been interested in the educational needs of linguistically diverse students. They have been influential in addressing the linguistically-based inequalities associated with minority languages (White et al., 2014).

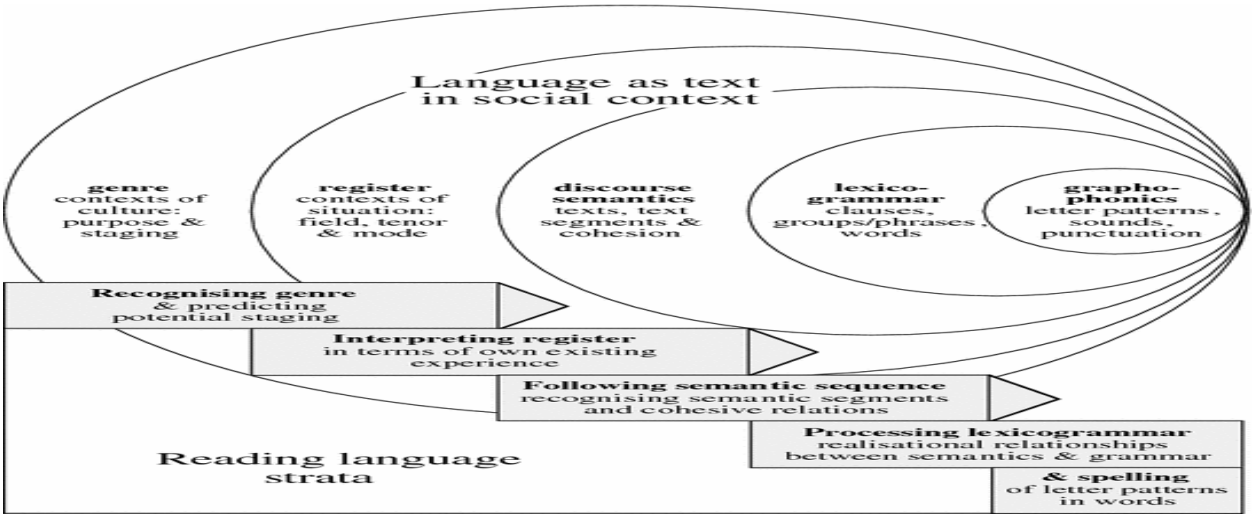
Furthermore, an SFL perspective states that schooling consists mainly of linguistic processes because "learning language" and "learning through language" are simultaneous (Schleppegrell, 2010). Therefore, second language (L2) students' language abilities are continuously assessed in English language tasks. Therefore, without a linguistic pedagogy

underpinned by *decontextualization, explicitness,* and *complexity,* their academic challenges are essentially linguistic complications. Accordingly, SFL based approaches can inform teachers' pedagogy because they create spaces where students are inducted into the different types of STEM genres and their associated registers, such as explanation, argumentation, information reports, explanation, and procedural reports.

Interestingly, SFL researchers argue that learning at schools is done primarily through language, yet that the language of school tasks is seldom explicitly discussed or taught (Schleppegrell, 2010). Even more interesting is that SFL educational linguists have combined Halliday's view of language as a meaning-making resource with Vygotsky's (1978) theory of the social environment as a fundamental mediator in learning new concepts (Harman, 2018). Therefore, SFL theory offers practical terms referred to as metalanguage to explain the relationship between linguistic choices and the situational contexts in which the language is used (Halliday & Matthiessen, 2014). Thus, understanding a language means understanding how people use the language in context. For example, when writing an email message to a friend, one would choose particular lexico-grammatical functions, which are different from those used when writing an email message to inquire about a job. As a result, SFL genre-based pedagogy, built on the idea of language use as functional, makes explicit how human experience becomes visible in language use within a context of culture and situation (see Figure 1 that follows).

Figure 1

Language use in the context of science



Note. Figure 1 illustrates how the language is constructed and used from Martin & Rose, 2003, p.17.

Firstly, the context of culture represents potential types of genres that are recognizable among the members of a particular culture (Schulze, 2015). This means that people unconsciously change their language use according to the social context to suit the purpose and specific linguistic features accepted within the cultural context before participating in any communication. For SFL, genres are a "staged, goal-oriented social process": (a) 'social because we participate in genres with other people; (b) goal-oriented because we use genres to get things done; (c) staged because it usually takes us a few steps to reach our goals (Martin & Rose, 2003). The conceptualization of genre can be robust in EMI STEM contexts. If teachers know the genres of their disciplines, they can make explicit the metalanguage, stages, and purpose of knowledge production in STEM subjects.

Secondly, the context of the situation is about the more immediate environment of the text. It foregrounds the register's linguistic choices based on three metafunctions: field, tenor, and mode (Halliday & Hasan, 1989; Halliday & Webster, 2004; Schulze, 2015). The context of the situation can assist teachers in scaffolding the way language changes in various domains

such as in the formal, informal, technical, familiar, and specialized contexts. For example, the registers of STEM genres can be highly specialized and technical compared with informal registers in everyday spaces. To understand the register of a particular context of situation, teachers would need knowledge of (a) the field which refers to the processes, participants, and circumstances; (b) the tenor, which refers to power-relations between the speaker and the audience and (c) the mode which is the method of delivery (written, spoken, multimodal) (Halliday & Hasan, 1989; Schulze, 2015). Consequently, knowledge of genres and registers in subject-related contexts is critical, especially in the STEM subjects, because of the dominant use of abstract and technical linguistic choices (Schleppegrell, 2004).

Thirdly, SFL connects and makes explicit the discourse semantics associated with purpose and audience. For example, STEM subjects are usually described as "thing-oriented" because personal feelings, relationships, and values are avoided, which means no or limited use of personal pronouns, informal language, conjunctions in favor of passive voice, nominalization, and formal language (Schleppegrell, 2004, p.117). For this reason, the challenges that students in EMI STEM classes face reflect linguistic issues because each subject has its own "expectations in terms of the genres that students will read and write, and each genre is constructed through grammatical resources that construe the disciplinary meanings" (Schleppegrell, 2004, p.113). As a result, combining the context of culture, the context of situation, and discourse semantics can make explicit the relationship between registers and knowledge production in STEM subjects.

The formal registers that characterize STEM content and the importance of linguistic decontextualization and intentional scaffolding have become prominent in research projects. For instance, in the US, Schleppegrell (2013) focused on metalanguage and illustrated the

importance of making visible the difference between formal and informal registers when teaching in EMI contexts. This design-based research included data from English language learners (ELL) in Grades two to five classes. The findings showed that learners quickly develop informal registers while interacting with people in their home and the everyday environment, but the formal, academic registers of schooling require explicit instruction. As a result, in this context, teachers' professional development was underpinned by genre-based pedagogies to illustrate the disciplinary language in STEM classes because the language of mathematics evaluates students' math understanding and their language proficiency (Veel, 1999).

2.2.1. Mathematics, Registers, and Disciplinary Linguistic Knowledge

The focus of SFL on language as a social semiotic was instrumental in illustrating the linguistic complexity of mathematical terms and how it contributes to mathematical processes and genres such as argumentation (Halliday, 2000). For example, mathematical arguments use abstract language, are precise, to the point, and mathematically logical (Forman et al., 1998). Marks and Mousley (1990) argue that mathematics is the language of numbers and multimodal because it combines written and oral communications, gestures, drawings, and diagrams. Additionally, O'Halloran (2005) highlighted how mathematical registers foreground processes, representations and symbolism, and their role in construing mathematical meaning. Therefore, even mathematics consists of metalinguistic registers that are predictable and have unique text types and genres. As a result, SFL-based pedagogy can be instrumental in making explicit the language of math, especially in contexts where teachers and students learn through a language they are not proficient in (Accurso et al., 2017; Segerby et al., 2018; Herbel-Eisenmann et al., 2013).

Research studies at the primary school level illustrate the advantages of SFL-based pedagogy in mathematics teaching. For instance, the research explored how the combination of reciprocal teaching and SFL can create a pedagogic design for developing students' reasoning for specific math tasks (Segerbyet al., 2018). This study included one 45-year-old male mathematics and science specialist who teaches eighteen students in a Swedish Grade 4 classroom. The data included triangulation of classroom observation, diary notes, and students' notes. They found that an SFL-based pedagogy expanded the students' language awareness and developed their mathematical register for reasoning.

At the secondary school level, a study conducted with 55 secondary school math teachers in the US investigated the impact of an SFL-based pre-service training on their metalinguistic knowledge of mathematics (Accurso et al., 2017). The findings pointed out that these participants demonstrated expertise in SFL pedagogy, which was visible in their ability to scaffold math disciplinary content, set clear expectations for their students, and develop math disciplinary language knowledge to provide explicit and practical feedback. Therefore, what is needed is more empirical-based research to show the extent to which SFL can improve teachers' metalinguistic knowledge of mathematics. As a result, professional development programs associated with genre-based pedagogies have drawn interest because they focus on developing teachers' knowledge of mathematical genres, registers, and multimodal symbols.

2.2.2. SFL and Professional Development (PD)

In many international contexts, PD projects draw on SFL to develop STEM teachers' metalinguistic knowledge of their disciplines (Fang & Coatam, 2013; Humphrey, 2017; Schleppegrell, 2018). In Sweden, the SFL Reading to Learn Project offered school-based support, highlighting increased literacy levels of immigrant students for whom Swedish was a

foreign language (Acevedo, 2010). Similarly, a European Union project, the Teacher Learning for European Literacy Education (TeL4ELE, 2011-2013) in five countries with 2450 students in ninety-seven classrooms, found that learners improved by "an average of 14.3% on their writing and 9% on their reading" (Coffin et al., 2013, p. 3). Also, in Spain, research studies highlight that SFL holds advantages for improved CLIL pedagogy (Llinares & Morton, 2010, 2017). Finally, in Asia, the induction of teachers into SFL genre-based pedagogy positively impacted EMI in Singaporean classrooms, particularly in international literacy tests (Kramer-Dhal, 2008). In Hong Kong, SFL-based pedagogy sheds light on how explicit scaffolding positively impacted learner results in CLIL classrooms (Lin, 2015; Polias & Forey, 2016; Wu & Lin, 2019; Lin, 2020).

Moreover, in the USA, SFL research shows the advantages of developing teachers' disciplinary knowledge (Buxton et al., 2019; Gerbhard, 2019). Accurso's (2017) review of SFL based PD programs provided a valuable snapshot of SFL-based pedagogy associated with STEM teaching. This review investigated the impact of SFL on the development of teachers' disciplinary linguistic knowledge (DLK) and its implications for classroom practice. Also, Gebhard (2010) describes three teacher education programs in the US and highlights how SFL-based training enhanced teachers' knowledge of academic registers. The study revealed that an SFL approach enabled linguistically-based discussions about knowledge production in STEM subjects. It also provided linguistic-based support for emergent L2 writers and developed greater teaching confidence among the participants.

Santiago Schwarz and Hamman-Ortiz (2020) reviewed SFL-based pedagogies associated with student writing in disciplinary or content subjects and found that SFL was useful in US contexts. Here, four distinct themes, namely, (1) composing genre-specific texts;

(2) mastering the academic language and literacy skills; (3) learning content across academic disciplines; (4) developing critical language awareness. Interestingly, the study revealed that the SFL-informed approach to teaching science enabled students to move beyond simply classifying the three rock types to understanding the interrelation between their unique components and the different processes that lead to their formation. In addition, research that focused on putting SFL theory into practice showed that students improved their recognition of how language is used and developed their metalanguage (Schulze, 2015). Consequently, research about SFL-based pedagogy in disciplinary contexts is a useful analytical lens to shed light on the registers or disciplinary literacies associated with mathematical teaching and learning.

2.3. Critiques of SFL

Heugh (2015) states that genre pedagogy is often criticized as dull and formulaic when teachers misinterpret its use. Secondly, content teachers may find it too complex and consider that they are not teaching language, leading to a static reproduction rather than a critical analysis of disciplinary discourse. However, successful PD programs associated with genre pedagogies illustrate the advantages of developing students' critical language awareness about the power relations hidden in the language (Rose & Martin 2012; White et al., 2014). Despite the criticism of SFL, it can provide teachers with a good understanding of academic language. Thus teachers could be better prepared to design language-focused and instructional scaffolding to accelerate English language learners' academic literacy development (Schulze, 2015). Also, when the second language is less familiar, it becomes more demanding to comprehend and understand the subject language because it differs from everyday language (Schleppegrell, 2004). Furthermore, making the grammatical and lexical choices that realize

academic contexts requires expertise and a desire to engage in those contexts and knowledge of the highly regarded grammatical and lexical choices (Schleppegrell, 2004). Therefore, despite criticisms of SFL, its potential shows more significant advantages for teachers and learners because it makes explicit the relationship between language and subject-specific content.

2.4. Conclusion

In conclusion, this chapter presented the theoretical and conceptual underpinnings guiding my research problem and the analytical framing. First, in section 2.1, I gave definitions of translanguaging, traced the historical roots of translanguaging and its development. Then, I explored translanguaging in the US, South Africa, the UK, and Kazakhstan, followed by research studies that combine translanguaging and SFL. Secondly, in Section 2.2, I introduced SFL theory, then presented SFL research studies associated with content-based pedagogy, mathematical disciplinary knowledge, and professional development. Lastly, this chapter provided some critiques against the SFL theory and concluded with the advantages SFL holds for my research project. The next chapter will describe the research design, data collection tools, sample and site selection, and ethical considerations that guided this study.

Chapter 3: Methodology

The previous chapter presented the literature that underpins this study, where I traced the roots of translanguaging and then explained SFL-based pedagogy associated with translanguaging and mathematics. In Chapter Three, I will now situate the methodological paradigm that informed this research project. Therefore, this chapter foregrounds the qualitative research literature to justify my decisions for the research design, the research site, and the participants. Finally, it highlights the ethical considerations taken to protect my participants' anonymity and confidentiality.

3.1. What is Research?

Research is a systematic "process of steps used to collect and analyze information to increase our understanding of a topic or issue" (Cresswell, 2014, p. 17) or simply "trying to find answers to questions" (Dornyei 2007, as cited in de Silva Joyce & Feez, 2016, p.227). Generally, there are three types of research methodologies: qualitative, quantitative, and mixed methods, each with its own epistemology and ontology that impact data collection, data analysis, and interpretation (Creswell, 2014). For example, quantitative research investigates cause-effect phenomena, whereas mixed-method research involves qualitative and quantitative research methods in a single study. In addition, qualitative research focuses on research that promotes a deep understanding of a social setting from the research participants' perspective (Creswell, 2014; Creswell & Creswell, 2018). As a result, qualitative research offers a fluid reality where a researcher can interpret how individuals or groups participate and experience various situations or contexts, and it requires researchers to search for multiple interpretations or "multiple frames of reference and systems of meaning-making" (McGuirk & O'Neill, 2016, p. 10).

This thesis is based on a qualitative research design because it offers an interpretative frame into the world of other people and their perspective of their social context; thus, it provides a holistic understanding of the particular phenomenon under the study (Bloomberg & Volpe, 2019). There are two essential advantages of using qualitative research: (1) its flexibility because the researcher can modify and change the instruments and revise the research question; (2) using multiple data tools offers an opportunity to triangulate the results based on reliability, trustworthiness, and validity. In addition to that, open-ended questions and the multimodality of resources (text and image analysis) as emerging methods make this research design unique (Creswell & Plano, 2018).

3.2. Research Design

This research project will follow a qualitative research design to better understand teachers' translanguaging practices in two mathematics classrooms (Creswell, 2014). Hence, the study aims to shed light on a particular classroom context and the participants' interactions therein; thus, a qualitative paradigm underpins this study. However, each context is different; Patton (1985) explains that the purpose of qualitative research should be to:

> ... understand situations in their uniqueness ... a particular context and the interactions there … not attempting to predict what may happen … but to understand the nature of that setting, what it means for participants to be in that setting, what their lives are like, … what the world looks like in that particular setting (as cited in Merriam, 1998, p. 1).

Therefore, this study applied purposeful sampling within the qualitative research design because I anticipated that it would provide a deeper understanding of the phenomenon, the specific research site and allow the participants to freely describe their unique social

setting (Creswell, 2014). This type of sampling can provide a thick description because the researcher as an instrument describes the location, the participants, and their experiences in detail to offer interpretations that will help the reader generate an interpreted meaning of the setting and the participants (Bloomberg & Volpe., 2019).

3.3. Research Site

The research was conducted at one Nazarbayev Intellectual School (NIS) school in Nur-Sultan. The participants were from two different education backgrounds that provided contextually rich data about these participants' teaching methods and translanguaging practices. Therefore, the selected participants described what their world looks like in a NIS setting and provided rich comparative data about EMI implementation in mathematics classrooms. However, access to the research site depended on several factors, such as permission of the school dean and the teachers' agreement to participate in research. To gain entry into this context, I emailed the department head to request permission to introduce my research project to all mathematics teachers. However, I couldn't personally visit the school because of restrictions due to the Covid-19 pandemic. Nonetheless, I provided potential participants with an information sheet about my study, including my contact details. I requested that they email me should they wish to participate in the proposed research project. Once potential participants were confirmed, they received additional information and consent forms that explained the purpose, research method, instruments, and measures to protect their identities.

3.4. Participants

The purpose of this study was to explore Kazakhstani STEM teachers' translanguaging practices. The initial participants were two biology teachers from one NIS and one mainstream

school, but due to Covid-19, I had challenges finding participants from mainstream schools. For this reason, the participants were two mathematics teachers from one NIS school in Nur-Sultan city in Kazakhstan, selected according to the following two characteristics: (1) to have more than two years experience of teaching mathematics through EMI; (2) to be a native speaker of the Russian or/and Kazakh languages. I anticipated that these two teachers with different educational backgrounds would give rich data on EMI implementation and its similarities and differences in the two classrooms.

3.5. Data Collection Instruments

A significant feature of qualitative research is that the researcher is the primary instrument for collecting and analyzing data (Merriam, 1998). Therefore, the researcher forms a deep connection with the participants, which could pose several threats to the validity of a study. For instance, the researcher's personality, educational history, culture, and social background could impact the interpretation of their participants' actions, beliefs, and values (Vierra & Pollock, 1998). Therefore, to counteract such validity threats, this study included various research instruments aligned with the notion of triangulation, strengthening the reliability and validity of the data (Creswell & Creswell, 2018). As a result, I included three research tools: document analysis, semi-structured interviews, and qualitative questionnaires.

Document Analysis

Fraenkel and Wallen (1993) define document analysis as" the analysis of a document's written or visual contents" (p. 389). My secondary data included analyzing documents such as the math syllabi that shape these two teachers' practices in the classroom and sample tasks from a mathematics textbook that illustrated disciplinary language. Finally, teachers'

homework samples were collected. The analysis of these documents sheds light on the mathematical genres and their associated registers.

Audio-recorded Semi-structured Interviews

It is essential to understand that conducting interviews requires "the careful asking of relevant questions" for researchers to validate their understanding of observations or questionnaires (Fraenkel & Wallen, 1993, p. 385). However, due to Covid-19, I was unable to conduct classroom observations. However, these interviews shed light on math teachers' perspectives and beliefs about EMI because the purpose was to "find out what is on [participants'] mind - what they think or how they feel about something" (Fraenkel & Wallen, 1993, p.385).

Furthermore, I conducted semi-structured interviews because I had a broad idea of the context of the research site. Therefore, I did not have a predetermined set of questions because I wanted to understand the research problem from the participants' perspective (Nunan, 2005). Thus, I designed an interview schedule consisting of broad questions that allowed the participants to recount their experiences. I encouraged and elicited contextual examples when I was unsure about the participants' sense-making of EMI in the mathematics classroom (see Appendix C).

Qualitative Questionnaire

According to McLafferty (2010), qualitative questionnaires allow for gathering original information about participants, their practices, experiences, beliefs, and values that underpins the decisions they make in their unique contexts. For this reason, I supplemented the interviews with a qualitative, multimodal questionnaire to triangulate the teachers' responses. The first section of this questionnaire focused on the teachers' backgrounds, such as their age, educational background, training, experience, and professional development. (see Appendix

A). The second section focused on these teachers' EMI experiences, the languages used in the classroom, and their attitude towards using students' language repertoires when teaching mathematics.

3.6. Data Collection Procedures

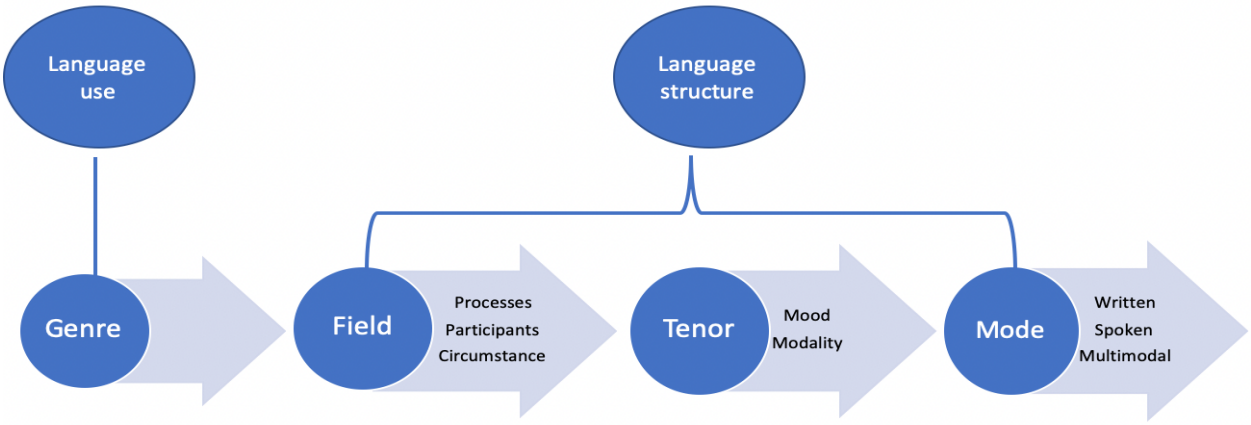
Once I identified the participants who agreed to participate in the study, I emailed them an information letter and consent form. I invited and thanked them for agreeing to participate in the study. The information letter provided details regarding the purpose of the research and additional features of the research project. Once I formed a rapport with the participants, I requested that they send the required secondary data for document analysis. Then, I asked that they complete the questionnaires, which I analyzed to identify potential translanguaging practices that provided a context for the interview because clarification and additional explanations informed the interview schedule. We collaborated on and confirmed an appropriate time to conduct interviews with the teachers. Due to Covid-19, I had to complete the interviews via my mobile phone, and each interview lasted approximately 30-35 minutes.

3.7. Data Analysis Framework

This study has drawn on an SFL analytical frame that included field, tenor, and mode for document analysis and appraisal resources (tenor dimension) to shed light on teachers' metalinguistic knowledge of mathematics and their perceptions translanguaging in the Kazakhstani context. See Figure two below for the analytical frame that focused on how language was used and how it was structured for use to achieve the purpose of the mathematical text.

Figure 2

An adapted version of the SFL framework



Note: This figure is adapted from *Martin & Rose., 2008, p.17*

The above frame informed both the document analysis for coding and the text annotation associated with purpose, structure, and language features to illustrate the mathematics genres, mathematical registers, and disciplinary literacies that our mathematics teachers would need for more effective translanguaging and EMI practices. Then, the emoticons in the questionnaire were coded for affect, judgment, and appreciation to make associations with the teachers' attitudes and beliefs about translanguaging. Finally, the recorded and transcribed interview extracts were coded and analyzed for patterns related to evaluative resources such as affect, judgment, and appreciation to shed light on when and why teachers switch languages in their mathematics classrooms. As a result, in analyzing the data sets, I captured how language users "describe their feelings and attitudes towards aspects of the world" (Martin & Rose, 2008, p. 137).

3.8. Anonymity and Confidentiality Procedures

This research project adhered to the established ethical standards governing research; however, ethical issues are especially critical when conducting qualitative rather than quantitative research (cited in Dörnyei, 2007). Therefore, I have taken all the necessary precautions to follow the ethical guidelines governing research to minimize any potential risks before, during, and after the data collection process. Most importantly, the Graduate School of Education at Nazarbayev University approved my ethics application. Moreover, I have taken precautions to keep all data strictly confidential, and I informed and reminded the participants about the confidentiality and anonymity measures taken in this study. Hence, I changed all participants' names and replaced them with codes to protect their anonymity. Essentially, I informed the participants that (1) all the study-related documents, research data, and protocols would be saved on a password-protected USB flash drive, (2) be kept in a password-protected computer or locked office to ensure their confidentiality, anonymity, and their school identity.

3.9. Conclusion

This chapter presented the methodological paradigm that informed this research project. Therefore, this chapter foregrounded and defined the qualitative research literature that justifies my research design decisions, the selection of the research site and the participants, and finally, the ethical considerations to protect my participants' anonymity and confidentiality. The chapter that follows will present and analyze the data and discuss the findings.

Chapter 4: Presentation, Analysis, and Discussion of the Data

The previous chapter focused on the methodology, the research tools, and the ethics that underpin this research project. As mentioned in Chapter 3, this qualitative research inquiry intended to provide an in-depth account of translanguaging in two EMI mathematics classrooms. An SFL analytical frame underpins this study and included field, tenor, and mode for document analysis and appraisal (tenor resources). These tools informed the design of the qualitative questionnaire and the analysis of the conducted interviews to shed light on the perceptions of mathematics teachers towards translanguaging in the Kazakhstani context. As a result, the triangulation of data provides validity and reliability for the study.

This chapter presents the data, the analysis of this data, and the discussion of the findings. First, I present the qualitative questions (4.1), then the document analysis to shed light on the genres, language features, and disciplinary literacies associated with mathematics (4.2). The interview extracts follow this to illustrate the participants' experiences of EMI in mathematics classes (4.3). Finally, this chapter concludes with a discussion of the findings (4.4).

This study consisted of two participants from one school in an urban area in Kazakhstan. According to research ethics, the participants have been named Participant A and Participant B to protect their anonymity and safeguard their privacy rights. The following section presents the results of the qualitative questionnaires.

4.1. Presentation and analysis of the qualitative questionnaire

The purpose of the multimodal questionnaire was to shed light on the participants' profile, educational backgrounds, and their beliefs about the impact of EMI in mathematics teaching. It consisted of 15 questions about their biographical information, their language

usage in the mathematics classroom, and their feelings about EMI in mathematics learning. As a result, the instrument included a combination of language and emoticon descriptors drawn from SFL's APPRAISAL system (tenor) because these emoticons shed light on how language users "describe their feelings and attitudes towards aspects of the world" (Martin & Rose, 2008, p. 137). See Figure three for the representation of each emoticon (positive-appreciative-neutral-unsatisfied-negative).

First, the questionnaire revealed that both participants were aged between 25-30 years and had worked at NIS for two to five years. Participant A is a male with a Bachelor in Mathematics from the only autonomous university in Kazakhstan; at the time of data collection, he was registered for a Masters in International Development at a university in Russia. On the other hand, Participant B is a female who graduated with a Bachelor's in Mathematics at another well-known university in Kazakhstan (see Table 1).

4.1.1. Participants' profile

First, the questionnaire revealed that both participants were aged between 25-30 years and had worked at NIS for two to five years. Participant A is a male with a Bachelor in Mathematics from the only autonomous university in Kazakhstan; at the time of data collection, he was registered for a Masters in International Development at a university in Russia. On the other hand, Participant B is a female who graduated with a Bachelor's in Mathematics at another well-known university in Kazakhstan. Interestingly, both participants revealed that they have not participated in recent professional development programs (see Table 2).

Table 1

Participants' Profile

Name	*Gender*	*Age*	*Teaching experience*	*Education*	*Context*
Participant A	*Male*	*25-30*	*2-5*	*NU (bachelor); PFUR (master's)*	*NIS*
Participant B	*Female*	*25-30*	*2-5*	*ENU*	*NIS*

4.1.2. Teachers' and Students' Language Repertoires in the Classrooms

Section 2 of the questionnaire focused on the language repertoires of participants and their students. The data revealed that Participant A chose Kazakh and Russian as his first language, whereas Participant B only referred to Kazakh as her first language. The data also illustrated that both the Kazakh and Russian languages are the first languages of their students while English is the language of teaching in both classrooms. However, the previous MOI in Participant A's classroom was Russian, whereas Participant B indicated both Kazakh and Russian as being her previous MOI (see Table 2).

Table 2

Teachers' and Students' Language Repertoires in the Classrooms

Name	Participants' first language(s)	Students' first language(s)	Current MOI	Previous MOI

Participant A	Kazakh/Russian	Kazakh/Russian	English	Russian
Participant B	Kazakh	Kazakh/Russian	English	Kazakh/Russian

4.1.3. Teachers' Perspectives of Language use in STEM Classes

The third part of the questionnaire consisted of five questions that focused on teachers' perspectives of language use in their subjects. The purpose was to shed light on their attitudes towards using their students' first language. In this section, participants had to circle the emoticons scaled from positive to negative. The first one was most positive, and the last one being most negative (see Figure 3).

Figure 3

Emoticons

The first question focused on teachers' feelings about teaching STEM through EMI. For this question, participant A chose the "positive" emoticon. At the same time, Participant B stated her opinion in written form by writing, "Good because there are many materials and sources for teaching." In addition, Participant A was positive about EMI, while Participant B noted, "In general good, but students sometimes have problems with understanding."

Furthermore, both participants indicated that they are using the Kazakh and Russian languages while teaching mathematics. They allow their students to use their first languages, which are also Kazakh and Russian. Interestingly, Participant B highlighted that she uses these languages to explain mathematical terms. In contrast, Participant A highlighted three different reasons for switching languages, such as changing languages to teach mathematical terms, provide instruction for activities, and remind students about their behavior. Lastly, the questionnaire included items associated with participants' attitudes towards using students' first languages during EMI mathematics teaching. Here, Participant A chose the "appreciative" emoticon, and Participant B wrote: "students start learning math entirely in English only from Grade 9; therefore, they sometimes use their first language".

Figure 4

Participant B's Response

Хорошо, есть много хороших материалов и источников для преподавания

4.1.4. Discussion of Qualitative Questionnaire

Interestingly, the questionnaire revealed how local school challenges associated with EMI have resulted in multilingual social practices where math teaching and learning have offered teachers and students spaces to use their multilingual repertoires to negotiate meaning. For example, both participants indicated their positive affect (feelings) towards EMI teaching

and the use of students' first languages. Even more interesting is that the participants draw on their students' linguistic repertoires to introduce subject-specific terms and explain activities. Thus, they displayed a positive affect on students' L1 and an appreciation for the availability of English materials to facilitate effective EMI in their math classes. Furthermore, allowing students to use their first languages shows that participants are applying a student-centered approach rather than a teacher-centered one because using students' first language will empower them to be active participants rather than passive listeners (Garcia & Wei, 2014; Creese & Blackledge, 2010). This languaging practice shows their tolerance towards their multilingual students' needs that can contribute to content and language learning because students' home language is utilized as a resource when scaffolding mathematics content (Lin & He, 2017). As a result, the questionnaire revealed positive affect associated with languaging or translanguaging in these two mathematics classes because both teachers were flexible about using their learners' L1.

4.2. Presentation and analysis of documents

This section will present the syllabus, a sample from students' textbooks, and teachers' home tasks. I have included these documents to explore the metalinguistic knowledge of mathematics both teachers and students would need within this context to implement an explicit translanguaging pedagogy.

4.2.1. Subject Syllabi

The document below forms part of the teachers' syllabus for NIS mathematics 10th grade (Figure 5). See Table four for the analysis of the mathematics syllabus that illustrates how language is used and how language is structured to achieve its communicative purpose.

Figure 5

Mathematics Syllabus Guide for Teachers

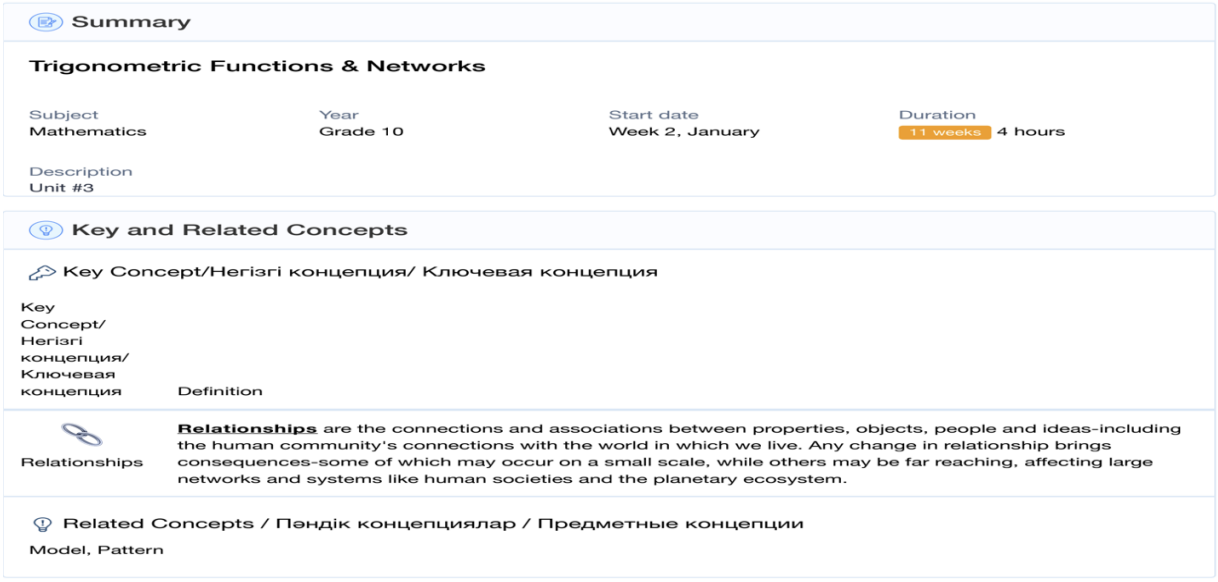


Table 3

Analysis of the Mathematics Syllabus Guide for Teachers

Purpose: **To give information trigonometric functions and networks**

Information Genre

How is language used in the document to achieve its purpose?	
Layout of information, key concepts, listing, and various fonts	Structure- it has several sections with related information in each and additional data to support the information provided

Audience-math teachers' unequal relationship with the audience Use of Russian and Kazakh		Formal language, not addressing the audience directly Key concepts translated which is indicative of the context
How is language structured for use to achieve its purpose?		
Field	Education-mathematics, specifically Trigonometric function	Noun phrases and process, circumstances (Trigonometric function, model, pattern)
Tenor	Mood: declarative Modality: no modality	It is declarative because it primarily consists of statements that convey information about the grade, hours, and focus of this topic. No modality because the text uses passive voice and uses no personal pronouns.
Mode	Written	Title, headings, and subheadings, bold font shows written because language is formal and technical nominalization- connections, associations.

From an SFL perspective, this document is an information report genre because it provides information about trigonometric functions, key concepts, or related terms to teach a lesson.

Firstly, the structure shows information about the title, grade, start date, duration, and explanations of the key concepts. Therefore, it has a clear, informative purpose that is visible

in the definitions and related terms. Secondly, the language in this genre functions as an information report because it outlines the requirements, situates the audience, and provides supporting information. Thirdly, the language structure indicates the social purpose because the structure clarifies that the topic is trigonometric functions and networks, followed by five subheadings that function as a guide for teachers. The audience is teachers because the document outlines a set of requirements about the subject, guides the teaching of this subject, and uses formal language that creates an unequal relationship with the audience. As a result, the language structure illustrates that the overall purpose is to direct the teachers towards teaching students about trigonometric functions and networks.

The field consists of nouns, processes, and circumstances such as trigonometric functions indicating education in general and the subject of mathematics specifically. Therefore, the language is structured to make the field explicit because terms such as model, pattern, function, and network align with the text's purpose and context. Furthermore, the tenor of this text is formal because it does not use personal pronouns. Finally, the mode of this text illustrates a written discourse because nominalization such as "connections, associations" show modified nouns that usually indicate a formal, written discourse to increase "coherence and cohesion" (Schulze, 2015).

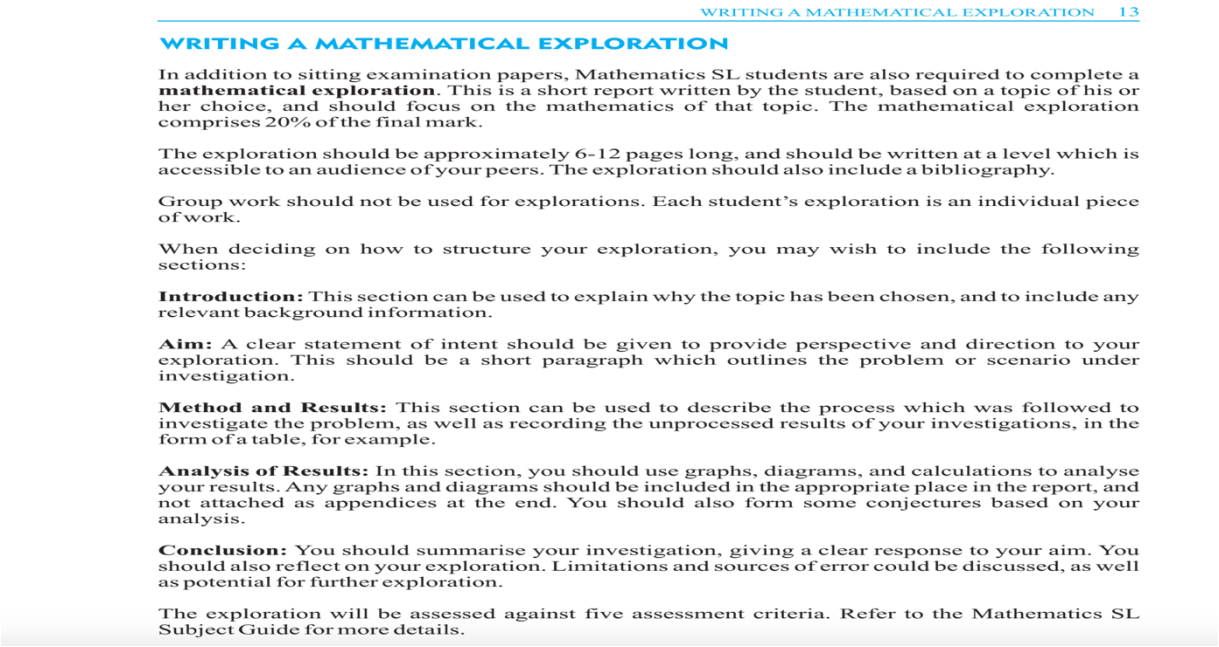
The next document for analysis is a Grade 10 student textbook.

4.2.2. Mathematics Textbook

The document below forms part of the students' book for NIS 10th-grade mathematics. This extract has been taken from the book's introductory section because it sheds light on language use in textbooks associated with mathematical teaching.

Figure 6

Mathematical Register for Writing a Mathematical Exploration



WRITING A MATHEMATICAL EXPLORATION 13

WRITING A MATHEMATICAL EXPLORATION

In addition to sitting examination papers, Mathematics SL students are also required to complete a **mathematical exploration**. This is a short report written by the student, based on a topic of his or her choice, and should focus on the mathematics of that topic. The mathematical exploration comprises 20% of the final mark.

The exploration should be approximately 6-12 pages long, and should be written at a level which is accessible to an audience of your peers. The exploration should also include a bibliography.

Group work should not be used for explorations. Each student's exploration is an individual piece of work.

When deciding on how to structure your exploration, you may wish to include the following sections:

Introduction: This section can be used to explain why the topic has been chosen, and to include any relevant background information.

Aim: A clear statement of intent should be given to provide perspective and direction to your exploration. This should be a short paragraph which outlines the problem or scenario under investigation.

Method and Results: This section can be used to describe the process which was followed to investigate the problem, as well as recording the unprocessed results of your investigations, in the form of a table, for example.

Analysis of Results: In this section, you should use graphs, diagrams, and calculations to analyse your results. Any graphs and diagrams should be included in the appropriate place in the report, and not attached as appendices at the end. You should also form some conjectures based on your analysis.

Conclusion: You should summarise your investigation, giving a clear response to your aim. You should also reflect on your exploration. Limitations and sources of error could be discussed, as well as potential for further exploration.

The exploration will be assessed against five assessment criteria. Refer to the Mathematics SL Subject Guide for more details.

Table 4

Analysis of the Mathematical Exploration Document

Purpose: **To give information and the procedures for performing a mathematical exploration**

mixed genre

How is language used in the document to achieve the purpose?	
Written information and instructions about a mathematical exploration	Structure- definition, information about task requirements, strategies for task completion, and assessment criteria

Audience math- students' language is both formal/informal		The text clearly outlines the "SL students." Equal relationship with audience-when giving instructions because they use modality such as may, should, and can. Unequal when giving information Unequal because they are using processes such as required and should (because if you do not follow the process, your task may be undervalued) for assessment criteria
How is language structured for use to achieve its purpose?		
Field	Education-mathematics	Noun phrases and process, circumstances (mathematical exploration, complete, comprises 20% of final mark)
Tenor	Mood: imperative and declarative Modality: medium modality	Statements of information about mathematical exploration or education such as assessment. Commands or requests such as required/should when giving instructions about the structure of mathematical investigation by using medium modality (should (levels of intensity of probability and obligation)) that creates an equal relationship as if it is requested, but students must do it to pass
Mode	Written	Title, headings, and subheadings, bold font shows written because it helps the audience to follow the text

Nominalization- investigation, limitation, exploration shows formality of written discourse

This text can also be classified as a mixed genre because it provides information associated with mathematical exploration, a set of instructions for task completion, and the assessment criteria for measuring success. Firstly, its social purpose is evident in how the language is structured for use in this text. For instance, it starts with a clear title, "WRITING A MATHEMATICAL EXPLORATION," followed by a definition of mathematical exploration with five bold subheadings that elaborate on this information. Also, it has a set of suggestions (instructions) to successfully perform the specific task, concluding with the assessment criteria. Therefore, this is a curriculum genre with a series of stages about a specific math task or assessment because the language is structured to give information and a set of instructions associated with assessment and student evaluation. Secondly, the audience is students as indicated by its purpose and reference to "students, mathematics students" and the use of personal pronouns such as "you" and "your" that function as references to the students. Thirdly, the language use situates the field consists of nouns, processes, and circumstances such as "mathematical exploration, required to complete, comprises 20% of final mark'' and terms such as "graphs, diagrams, calculations, mathematics'', which is indicative of the subject of mathematics and the completion of this particular task. Therefore, the language is structured and used in the field domain to situate the social context and audience and text's purpose. Fourth, the tenor of this text is both formal and informal. For example, personal pronouns such as "you, your," the declarative mood visible in the statements of information, and the use of modality such as "should/shouldn't" create an equal relationship with the audience. Here, language conveys the imperative mood (instructions)

stipulating the task assessment for the students. However, the tenor changes and becomes more formal when processes such as explore, examine, and investigate have been modified to nouns "exploration, examination, and investigation'' that provide some clarification and specification about how to complete a mathematical exploration successfully. Finally, language usage demonstrates that it is a written mode because nominalizations such as "exploration, examination, and investigation'' show formality and a context-reduced domain associated with mathematical pedagogic goals. The assessment constitutes the "content" of the mathematics syllabus.

Next, samples of the participants' homework tasks are presented and explained.

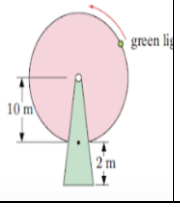
4.2.3. Teachers' Homework Tasks

This document illustrates samples of students' home tasks taken from the two participants. The purpose of analyzing the homework tasks was to describe the required language features and genres.

Figure 7

Sample Homework Tasks

<table>
<tr>
<td>Participant A</td>
<td>Participant B</td>
</tr>
<tr>
<td>
3 At the Mawson base in Antarctica, the mean monthly temperatures for the last 30 years are:
<table>
<tr><td>Month</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>July</td><td>Aug</td><td>Sept</td><td>Oct</td><td>Nov</td></tr>
<tr><td>Temperature (°C)</td><td>0</td><td>0</td><td>−4</td><td>−9</td><td>−14</td><td>−17</td><td>−18</td><td>−19</td><td>−17</td><td>−13</td><td>−6</td></tr>
</table>
a Find a sine model for this data without using technology. Use Jan ≡ 1, Feb ≡ 2, and so on.
b How appropriate is the model?

4 Some of the largest tides in the world are observed in Canada's Bay of Fundy. The diff between high and low tides is 14 metres, and the average time difference between high t about 12.4 hours.
a Find a sine model for the height of the tide H in terms of the time t.
b Sketch the graph of the model over one period.
5 Revisit the Opening Problem on page 232.
The wheel takes 100 seconds to complete one revolution. Find the sine model which gives the height of the light above the ground at any point in time. Assume that at time $t = 0$, the light is at its lowest point.


</td>
<td>
#2,#4, #6,#8
2 How much compound interest is earned by investing €20 000 at 12% p.a. if the investmen a 4 year period?
3 a What will an investment of ¥30 000 at 10% p.a. compound interest amount to after 4
b How much of this is interest?
4 How much compound interest is earned by investing $80 000 at 9% p.a. if the investment 3 year period?
5 What will an investment of ¥100 000 amount to after 5 years if it earns 8% p.a. compound annually?
6 What will an investment of £45 000 amount to after 21 months if it earns 7.5% p.a. com quarterly?
8 What initial investment is required to produce a maturing amount of £15 000 in 60 months given a guaranteed fixed interest rate of 5.5% p.a. compounded annually?
</td>
</tr>
</table>

Table 5

Analysis of Participants' Homework Task

Participant A	Participant B
Purpose: To provide instructions for completing a specific task	**Purpose:** To provide instructions for completing a specific task
How is language used in the document to achieve the purpose?	
A row of numbered tasks with subsections in Latin alphabetic numbering that use questions, cases, and pictures that depict tasks	A row of numbered tasks with subsections in Latin alphabetic numbering with six questions and sub-questions that foregrounds the task

Audience-students/unequal relationship	Audience-students/hidden unequal relationship
How is language structured for use to achieve its purpose?	
Field: **Education-Mathematics** Noun phrases and process, circumstances (find, sine model, without using a calculator)	**Field: Education-Mathematics** Noun phrases and process, circumstances (compound investment, earn, four-year period)
Tenor: Mood: imperative- requires students to execute specific actions Formal language, not addressing the audience Unequal relationship with the audience because of imperative words such as find, sketch, assume, no modality	**Tenor**: Formal language, not addressing the audience Hidden unequal relationship because it requires the students to complete the given cases Mood: imperative Modality: no modality It requires students to do specific actions

Mode: **Multimodal** It uses both pictures and written language; therefore, it is multimodal. List, central questions and sub-questions, italic font helps the audience to follow the text	**Mode:** Written List, central questions, and sub-questions shows written because it helps the audience to follow the text

Both homework samples are part of curriculum genres associated with teaching and learning. The purpose of both texts is to evaluate learning; this is visible in the use of the imperative (find, assume, revisit, sketch) and interrogative (what? how much?) moods, which means that students are required to complete a task if they want to demonstrate achievement of the content. Therefore, both texts reveal elements of a procedure that provide a clear set of sequenced directions or numbered questions for task completion.

The field is mathematics because of the mathematical symbols, terms such as "mean" and "sine," and the use of percentages, numbers, and words. Following that, the tenor is formal because there are no personal pronouns, and the use of nominalizations renders both samples formal. Participant A's document revealed an imperative mood because of processes such as "find" and "complete." At the same time, the second text is interrogative (Participant B) as it uses questions and complex sentence structures. For this reason, the language is abstract and lacks human participants (find sine versus you must find sine), which is a common feature in mathematics textbooks.

Interestingly, the mode dimension shows the difference between these two homework tasks; for example, Participant A's homework task is multimodal drawing on words and images to negotiate meaning, whereas Participant B uses the written mode only. Therefore,

Participant A's homework task shows how the linguistic, symbolic, and visual components contribute to mathematics discourse and register. In contrast, Participant B's homework task resembles a behaviorist approach visible in the decontextualized mathematic formulas that encourages regurgitation.

Finally, these homework tasks demonstrate a detached, formal, and authoritative voice that one would expect in a "mathematics register [which is] the meanings that belong to the language of mathematics (the mathematical use of natural language, that is: not mathematics itself), and that a language must express if it is being used for mathematical purposes" (Halliday, 1987, p. 175).

4.2.1. Discussion of document analysis

The document analysis revealed various genres such as the mathematics syllabus, an excerpt from a textbook, and teachers' homework tasks. Yet, they all contained similar purposes of giving information or directions to achieve a specific goal. Therefore, some of these documents had dual social purposes classified as mixed genres. First, the teachers' syllabus and students' textbooks displayed common patterns such as headings in bold, divided sections, highlighted words, the use of descriptions, and nominalization. Interestingly these features were missing in the teachers' homework tasks, which were sequenced as a list of numbered questions and tasks indicating that "the function and form of disciplinary genres are sometimes transformed in the context of schooling serving pedagogical and didactic functions" (Rezat & Rezat, 2017, p. 4202).

Secondly, the field drew on grammatical metaphors such as nominalization and technical mathematical terms that foregrounded the math-specific context in all these documents. Therefore, the field demonstrated mathematical discourse where language,

symbols, and the choice of visual images functioned as three semiotic resources that simultaneously conveyed mathematical sense-making.

Thirdly, to achieve the purpose, in each document, the language used mainly foregrounded an unequal relationship with the audience through *imperative* sentences that directed the audience to complete specific tasks. For this reason, effective translanguaging in mathematics classrooms would require teachers who are knowledgeable about mathematics genres, mathematical registers, and discourses and how semiotic resources such as language, symbols, and image jointly negotiate mathematical meaning. Furthermore, knowledge of the mathematical registers can facilitate intentional translanguaging or explanations about register choices and visual grammar associated with tables, graphs, figures, and charts because mathematics examines students' mathematical sense-making and knowledge of mathematical discourse (Veel, 1999). Consequently, teachers should be aware of the field and tenor's register choices necessary for negotiating the meaning of mathematical knowledge in school contexts, such as subject-specific terms and phrases associated with nominal phrases and relational clauses (Accurso et al., 2017).

4.3. Presentation and Analysis of Interview Data

This section presents the interview data analysis to shed light on the participants' use of translanguaging (when and why) and their beliefs about the impact of language in mathematics teaching. The interview schedule consisted of seven questions. The data revealed three main themes associated with translanguaging: challenges in EMI math classes, math pedagogy and language, and the rationale for translanguaging.

4.3.1. Challenges in EMI Math Classes

Contextual factors impact EMI and language practices at this school. These factors seemed to have affected the implementation of EMI. For example, EMI was delayed in Grade 8 and only started in Grade 9.

Extract 1:

> *Due to the fact that the school was established not so long ago, not all of the school population is ready for the English language. Therefore, there is a transition that until eighth grade, everyone is taught in their own language of instruction and starting from the ninth grade, all subjects are switching to English (Participant A, January 19th, 2021).*

The extract illustrates that the school was established recently, impacting the school and students' readiness to be taught through EMI. To combat this contextual dilemma, EMI subject teaching only starts from Grade 9. However, this switch to EMI at a later grade does not come without its challenges.

First, students' English language proficiency impacted their basic interpersonal communication skills (BICS) (Cummins, 1990).

Extract 2:

> *In the past the teachers of the ninth grades have encountered the problem: the fact that pupils do not understand anything in English in the classroom (Participant A, January 19th, 2021).*

This extract implies that students did not possess the primary English language proficiency needed for daily social interactions. The language used in these everyday social interactions is context embedded and normally face-to-face; thus, switching to EMI could be cognitively demanding, making the specialized registers and metalanguage of mathematics even more problematic and challenging.

Secondly, the teachers translated the teaching materials into English, but whether they make explicit the specialized mathematics discourses remain questionable.

Extract 3:

> *Therefore, literally … all mathematics … has to be translated into English and the entire ninth grade to spend some simple translated things. Their knowledge is duplicated into English; this creates an extra burden, respectively, for the senior classes (Participant A, January 19th, 2021)*

Interestingly, teachers commented on the duplication of the knowledge component into English. Again, it raises questions about scaffolding the math registers and language usage in the mathematics classroom. For example, the participants commented that explanations of mathematics could sometimes be challenging.

Extract 4:

> *There are no problems in terms of preparing the material and the lesson there are no problems, but in terms of the explanation of the materials, sometimes, on my part, there are also a few difficulties … so in terms of explanation, difficulties may arise…sometimes not all words we use are in English, sometimes we switch to Russian to explain something (Participant B, January 21st, 2021)*

From Extract 4, we see difficulties in EMI teaching and learning mathematics for both teachers and students. Generally, the extract illustrates that the different levels of L2 proficiency create significant language problems in mathematics classrooms. For this reason, there seems to be a preference for using the Russian language for academic purposes and especially for mathematical sense-making.

Extract 5:

> *However, the Russian language is still dominant. Because if some things are not clear, difficult to understand, then English isn't used for a while, perhaps in a classroom where the lesson lasts not 20 minutes, but 60 minutes it would be somehow different, but so far we have this kind of situation. In the 10th grade Kazakh classrooms, there is already a dominant role of the English and Russian languages as supporting languages (Participant A, December 12th, 2020)*

Translanguaging in this context draws on the medium of the Russian language. This means that Russian and English dominate when switching between codes, whereas translanguaging requires students' full linguistic repertoires, including the Kazakh language.

Finally, students' ability to cope with mathematical learning in English seems terminology-focused in Grade 9. Thus, learning the math content was associated with challenges in understanding new terms and unfamiliar words.

Extract 6:

> *I taught in 7th grade, and at that time, it appeared that I was giving some things incorrectly, and I learned it from colleagues after the event had happened. Respectively, this affected their communication in Russian, as well as their mathematics. Well, it turns out some new terms; cause difficulties when we read written tasks and unfamiliar words sometimes (Participant A, December 12th, 2020)*

Extract 7:

> *Well, yes, because they have been teaching in English since the ninth grade, and that's why in the two ninth grades, they study the terminology, and then they have the main terminologies in the ninth grade and in the 10th grade, it is already easier for them (Participant B, January 21st, 2021)*

In the previous extracts, the teachers' perspective associated with students' mathematical sense-making is merely seen as knowledge of terminology that suggests some behaviorist values related to math learning and teaching, thus creating opportunities for mathematical sense-making associated with a more profound comprehension of mathematical discourses. As a result, languaging between everyday and school-based mathematical literacies is omitted when teachers focus only on decontextualized mathematical words, concepts, and vocabulary translations.

4.3.2. Math Pedagogy and Language

In this section of the interview, the participants described a typical mathematics lesson. Interestingly, both participants appeared to be using inquiry-based and student-centered approaches to math teaching, but they also illustrated how language impacts their pedagogy.

Extract 8:

> *Initially, we don't tell them that the function F from X, the X equals X2, will have a parabola graph, and all this is discovered by students themselves. They do not know what the periodic behavior of functions is, that is, the periodicity of functions, but thanks to this example, they already see a wave-like function which is similar to that function. The lesson process is built so that, if possible, every nuance of the mathematical formula (term) should be revealed to the students in the process of discussion or in the process of independent work (Participant A, December 12th, 2020).*

The participants seem to be aware that the mathematics discipline requires problem-solving skills. Their responses indicate that they create mathematics classrooms that value students' independent thinking about how mathematical problems work. Furthermore, their pedagogy would probably enhance students' comprehension because they create learning spaces where their students can use their thinking and creativity in solving math problems. As a result, in this context, there was a paradigm shift from the previous Russian educational system that valued the memorization of facts and taking notes to one that encourages students to communicate, discuss and solve math problems among their peers.

Furthermore, their inquiry-based pedagogy is encouraged at the school level because criteria-based assessment (CBA) underpins NIS pedagogy and evaluation principles.

Extract 9:

> *There are four different criteria that are required in teaching in this NIS. Those are ABCD (said in English) criteria. A is for knowledge and understanding, B is the discovery of patterns using students' knowledge. C is for communication, and D is the application of mathematics in real life (Participant A, December 12th, 2020).*

This extract shows that the NIS assessment system emphasized mathematical content, communication, and using mathematics for real purposes. For example, teachers would have to encourage students to display mathematical knowledge and understanding that would have to be communicated and applied in class and real-life contexts. As a result, there is a socio-critical orientation to the mathematics curriculum that values student-centered pedagogy and life preparation at the institutional level. This orientation was also visible in the extract that

shows a preference for equal teacher-student relationships, thus strengthening the student-centered orientation of the school. However, what is less obvious are the strategies teachers need to scaffold both language and content in mathematics classes.

However, despite the teachers' inquiry-based pedagogy, the interview revealed that students' ability to understand math content was more than language or EMI.

Extract 10:

> *According to the development at the level of mathematics, it happens that someone learns mathematics better, someone worse. And the one who learns mathematics better, then he reads the topic and basically understands it. Therefore, it is easier for those to understand it in English and for someone with the same level of English to not understand what is happening there (Participant A, December 12th, 2020)*

In this extract, the teachers indicated that mathematical understanding is connected to EMI and commented that even though students might have similar English language proficiencies, math could be more straightforward for some students while it remains challenging for others. As a result, struggling students' mathematical sense-making goes beyond language, and the extract below demonstrates how teachers deal with this issue.

Extract 11:

> *It is also solved by the method of differentiation, that is, someone gets... everyone is given general examples, someone gets easier examples, and also, this is done in a way that is not noticeable for a student; everyone is given examples with medium complexity. Then, someone who has coped with medium complexity examples is immediately given difficult ones. Those who couldn't solve them are given a number of easy examples so that through them, they can come to the solution of medium complexity examples (Participant A, December 12th, 2020).*

The transcript reveals that teachers practice ability grouping to prepare mathematics tasks for three levels: easy, low, and medium. Even though differentiated teaching is an approach that caters to different abilities, it can hold unintended consequences for mathematical identity construction because students in the lower streams could become negative, impacting their motivation to learn mathematics.

4.3.3. The Rationale for Translanguaging in the Mathematics Classroom

The participants provided insights into how EMI is implemented in the local context and shed light on their languaging strategies to cope with the curriculum demands of learning mathematics through English. Firstly, Russian and English provide students with mathematical sense-making opportunities associated with the topic and content. For instance, from Grade 8, translanguaging strategies facilitate the switch to EMI MOI in grade nine.

Extract 12:

> *So what is happening at the moment is that we are using the CLIL method as much as it is possible. So for presentations, everything is in English, and everything is duplicated and explained in Russian, respectively, as soon as they see the presentation, all the information that is on the presentations is duplicated, that is, the first thing they see is the topic of the lesson and the topic of the lesson is explained in the Russian language and some necessary explanations are also provided (Participant A, December 12th, 2020).*

From this extract, we can see evidence of translanguaging using Russian and English because the materials are in English while the explanations are in Russian. It seems that translanguaging is conceptualized as a translation between the two languages to facilitate learning in CLIL classes. Therefore, despite EMI, the teachers acknowledge their students' multilingual repertoires as a resource to maximize the latters' meaning-making potential. If these translations of materials go beyond word-level subject terms, they would likely facilitate effective CLIL implementation because it would include the register and the metalanguage of mathematics. However, translanguaging appears to be related to the translation of content.

Referring to Grade 10, the participants commented the following:

Extract 13:

> *In the 10th grades, the lesson, basically, in terms of the theoretical component, is similar to the previous, that is, again, at the presentations, they see the topic of the lesson, this topic of the lesson is necessarily indicated as to why it is needed and how it is applied, that is, the same as in the eighth grade, but everything is in English. Sometimes, however, some things are selectively duplicated into Russian when it is necessary because, well, there is still a difficulty for students to understand everything in English (Participant A, December 12th, 2020)*

This extract shows a stronger focus on EMI in Grade ten because the lessons are in English only combined with translations of materials if necessary. Again, translanguaging provides an opportunity to facilitate students' sense-making of the translations of the topic, the purpose, and explanations associated with the application. Therefore, despite notions of inquiry-based pedagogy, teachers only draw on translanguaging to translate content; they did not indicate how they use language to scaffold students' mathematical understanding of the content and the language.

Additionally, the participants indicated that translanguaging takes place mainly in Criterion C of Criteria Based Assessment. Therefore, translanguaging occurs to develop students' communication skills in association with mathematics.

Extract 14:

> *That is, in order to cover Criterion C, the effectiveness of communication of mathematics is just the same method that is applied where the information is given in English; the definitions, goals of the lesson, some examples, and rules are given, and all this is translated by the student into Russian and immediately explained in his own language. The use of mathematical terminology is for the development of Criterion C, and if there are tasks on the slide, then the students accordingly solve the task (Participant A, December 12th, 2020)*

Extract 14 illustrates that students communicate in the target language; however, it mostly takes place through the medium of Russian. This is similar to the Welsh context where students received teaching in the target language and conversation occurred through their L1 (Garcia & Wei, 2014).

Furthermore, differentiated teaching is another reason for applying translanguaging associated with streaming students' mathematics abilities.

Extract 15:

> *The first difficulty is solved by the method of differentiation where we give (the tasks) for some of the students completely in English, for someone we simultaneously translate in Russian, of course, they don't know that we are translating for them (Participant A, December 12th, 2020)*

As we can see, differentiated teaching results in translanguaging that is related to the translation of materials. Interestingly, the Kazakh language also has its place in the mathematics classroom.

Extract 16:

> *When we translate mathematical terms in English into Russian, and it's not quite clear what is the theme, then if we will tell it in the Kazakh language, it becomes clear, and it is the only use of Kazakh (Participant A, December 12th, 2020)*

This extract illustrates a triple translanguaging practice that takes place using students' entire linguistic repertoire. Furthermore, it shows the dominance of the Russian and English languages and the minimal use of the Kazakh language. Finally, students' English language proficiency seemed to necessitate the use of translanguaging. Therefore, in these mathematics classrooms, teachers adopt flexible pedagogy to create languaging spaces that mediate complex cognitive tasks. As a result, teachers are aware of the advantages of viewing multilingualism as a resource in math pedagogy.

Extract 17:

> *for some students of basic language and mathematical abilities that is another matter…therefore, it is still allowed to use the Russian language well, or Kazakh wherever it is more convenient in order to better convey all this information. Therefore, it is often necessary to duplicate information into the Russian or Kazakh language, the second language of instruction, so that students understand better and (then) everything goes in English (Participant A, December 12th, 2020)*

From the above extract, it is clear that teachers foreground students' limited language proficiency and limited mathematical sense-making as the factors to "duplicate information." They believe that the translations facilitate meaning-making and that "everything would go in English." However, a translanguaging pedagogy requires students to learn new language practices; thus, "new ways of languaging is more difficult than just learning new subject content," and yet this new language discourse has not been considered (Garcia & Wei, 2015, p. 229). As a result, their attempts are commendable but, transformative translanguaging practices require more than just translations or producing content in the target language.

4.3.4. Discussion of Interview Data

Overall, the interview results suggest that teachers face various contextual level challenges associated with EMI in mathematics classes. The primary reason for these challenges is that this is a recently established school; thus, they were relatively unprepared for EMI implementation in Grade 8. For this reason, students' differing English language proficiencies result in translanguaging practices to counteract their challenges in understanding mathematical content through EMI.

Secondly, according to the interview analysis, translanguaging is mainly used to translate the topic, purpose, and math content. Therefore, teachers' translanguaging practices would not provide their learners with more opportunities to learn STEM (Probyn, 2019). For example, translanguaging goes beyond simple translations and code-switching and uses students' linguistic repertoires to create meaning-making (Garcia & Wei, 2015). Yet, in this translanguaging space, language usage did not develop meaning-making but offered opportunities to translate mathematical content. Nevertheless, similarly to Lin and He's (2017)

study, teachers' math content translations allowed students to use their L1 and offered a gateway to content-specific words important for sense-making.

Thirdly, translanguaging offered a strategy to support the participants' students' limited English skills. These teachers infused inquiry-based pedagogy and differentiated teaching using translanguaging to provide new possibilities for their students' mathematical sense-making.

Finally, the teachers applied translanguaging to develop communication skills, and it offered a space for students to become active participants in the learning and teaching process (Creese & Blackledge, 2010). As a result, students could use their full linguistic repertoires, be it Kazakh, Russian, or English, to communicate and make sense of the math content.

4.4. Presentation of findings

This section provides the main findings from three data sets: the qualitative questionnaire, documents, and interviews and draws on the SFL resources of tenor and appraisal, which are affect, judgment, and appreciation.

Firstly, the questionnaire analysis revealed that local school challenges associated with EMI have resulted in multilingual strategies for math teaching and learning, enabling teachers and students to use their multilingual repertoires meaning-making. For example, both participants indicated positive affect (feelings) and judgment towards teaching through EMI and the use of students' first languages. In addition, the teachers possess the following features: positive affect (student needs), judgment (English language proficiency), and appreciation (English books and resources) towards translanguaging practices. Therefore, they were flexible in using their students' L1. As a result, students' L1 and the availability of English materials facilitated EMI in their math classes.

Secondly, the document analysis revealed that the mathematical genres were mostly procedural and informational documents. These genres foregrounded abstract language, register choices, and mathematical discourses, impacting students' mathematical sensemaking. Furthermore, the field drew on grammatical metaphors such as nominalization and technical mathematical terms highlighting the math-specific context. Therefore, the field demonstrated that mathematical discourse associated with three semiotic resources such as language, mathematical symbols, and visual images simultaneously convey mathematical meaning. Consequently, teachers should be aware of the register choices in the field and tenor to effectively translanguage the mathematical knowledge and subject-specific terms encapsulated in nominal phrases and relational clauses.

Finally, the interview analysis also revealed the importance of teaching math registers explicitly because the participants indicated that even though some students had the same English language proficiency, they did not all perform at the same level. Such varying performance could be attributed to mathematical register, which can impact students' mathematical sense-making because those who are successful might come to school prepared for the language of schooling, making it easier to acquire the registers of their various subjects (Schlepegrell, 2014). The main reason for translanguaging was students' need for translations and code-switching to facilitate their understanding of mathematical content. Therefore, both participants showed a positive affect towards using students' L1 in EMI mathematics classrooms in the interview. In addition, while applying differentiated teaching, their translanguaging practice shows their appreciation for fostering positive student identities. As a result, the interview indicated participants' positive feelings towards translanguaging associated with facilitating students' understanding of the content but not developing their proficiency in both languages (Williams, 2002).

4.5. Discussion of Findings

This study explored the translanguaging practices of two mathematics teachers at one NIS school in Kazakhstan. To shed light on mathematics teachers' translanguaging practices, this study used a Systemic Functional Linguistics (SFL) lens to illustrate how language functions as a semiotic resource in these two mathematics classes. The previous section highlighted the findings obtained from the three research tools, the qualitative questionnaires, documents, and interviews. This section discusses the study results concerning the literature reviewed in Chapter 2 and the three underpinning research questions.

4.5.1. What Metalinguistic Knowledge do Mathematics Teachers need to draw on Translanguaging as a Pedagogical Tool?

The language of math includes specific linguistic choices that construct a particular reality for a specific social purpose (Halloran, 2005). For example, the documents revealed a range of information and procedural mathematics genres. Some were mixed genres because they had dual social purposes of giving information and a set of directions to obtain a particular goal. In addition, the documents showed that language items, visuals, and mathematical symbols simultaneously negotiate meaning, resulting in a small interpretative space (IS) and a direct semantic effervescence (SE) (Halloran, 2005), which makes math solutions and their procedures appear straightforward. Therefore, to implement effective translanguaging practices, math teachers should have genre knowledge about how language functions in the field dimension in nominalization, graphs, figures, and charts. Also, teachers need to understand how language changes in the tenor dimension are primarily imperative because "the abstract nature of the processes and participants and the style of production of the text contribute to the dominating tenor" (Halloran, 2005, p.198). Furthermore, the mode

written, spoken, and multimodal, and teachers would need knowledge of how language changes in these different modes (Halloran, 2005). As a result, teachers' must have metalinguistic knowledge about mathematics genres, registers, and discourses and how semiotic resources such as language, symbols, and images jointly negotiate mathematical meaning.

In addition, the interviews revealed that the teachers face various EMI-related challenges in the mathematics classroom. Firstly, students' English language proficiency resulted in translanguaging, while issues related to math understanding resulted in differentiated teaching methods. Secondly, the teachers revealed that English language proficiency was not always a criterion for success, suggesting that mathematics involves students' math understanding and language proficiency (Veel, 1999). For example, even though some students were proficient in the English language, their challenges can be associated with the "grammar of mathematical symbolism is not generally understood" (Halloran, 2005, p.15). Furthermore, the visual grammar associated with mathematical images such as diagrams, figures, and graphs needs explicit translanguaging to "explain how the systems are organized, to make very specific meanings which provide a link between the linguistic description of a problem and the symbolic solution" (Halloran, 2005, p.15). As a result, the teachers' challenges foregrounded their limited ability to draw on transformative translanguaging practices that would make explicit the way mathematical registers, symbols, and language jointly offer meaning-making resources (Garcia & Wei, 2015).

4.5.2. When and Why do Math Teachers Switch Languages?

The questionnaire revealed that both participants mainly use students' L1 for explaining mathematical terms. However, this practice does not coincide with translanguaging

as a pedagogical tool, because as Wei (2017) outlines, translanguaging is not only about switching languages when it is needed, but it is a transformative, re-semiotization process that promotes the use of languages for the creative and critical co-construction of knowledge.

Despite this, the interviews revealed that the Grade 8 teachers' and students' switch for both content and language because of the CLIL approach features and a gradual transition to total EMI. Switching to complete EMI can contradict the main aim of translanguaging: to contest monolingual assumptions (Garcia & Wei, 2014). Nonetheless, this Kazakh context is similar to CLIL classrooms in Hong Kong because students' home languages serve as a resource and the participants also switch for assessments because "effective communication of mathematics" (school designed the CBA) requires students to display good communication skills (Lin & He, 2017).

In Grade 10, teachers switch because of the content, but it seems like selective translation based on the needs of their students. However, the selectivity of such translations does not create translanguaging as a pedagogical tool because translanguaging goes beyond simple translations (Garcia & Wei, 2015).

Finally, they switch to differentiated teaching because of students' diverse English language proficiencies. As a result, the teachers only switch languages to translate subject-specific content in this context, but their responses indicated a limited ability to scaffold math register and metalanguage. However, translanguaging is not just about giving students access to the content; thus, transformative language practices associated with bilingual education were lacking in this context (Garcia & Wei, 2015).

4.5.3. How did these Language Switches Contribute to the Scaffolding of Content and Language?

Interestingly, the documents revealed NIS institutional approach to translanguaging because the information about lesson planning included Kazakh, English, and Russian. This type of translanguaging associated with the translations of materials was also visible in the interviews where the topics, purposes, and terms were translated to students' L1. For example, the teachers made a concerted effort to use students' L1 to facilitate content drawing on the translations of vocabulary and subject-specific terminologies; thus, they are competent in translanguaging in the field dimension. Similarly, the early versions of CLIL lacked a balance between content and language (Coyle, 2007). Likewise, Karrabassova (2020) pointed out that CLIL in the Kazakhstani context is heavily concerned with language rather than with a content. However, there should be a balance between the two when teaching. Accordingly, teachers should concentrate not only on translations of the content but also on teaching how language is used to negotiate the meaning of a particular topic to make it visible and comprehensible for learners' language development.

Furthermore, the documents illustrated differences in the participants' homework tasks. For instance, both participants attempted to facilitate mathematical content. However, one teacher displayed a more remarkable ability to include opportunities for his students to engage with multimodality, such as written texts, symbols, and visuals (Halloran, 2005). These multisemiotic resources have their own role in construing mathematical meaning and mathematical registers (Halloran, 2005). Therefore, this homework task showed some evidence of infusing mathematical registers and content. Nonetheless, both teachers would benefit from explicit language scaffolding because this would expand students' language awareness and develop their mathematical register for reasoning (Segerby et al., 2018). For example, the research conducted by Accurso et al. (2017) showed that SFL-based pre-service training helped teachers to set clear expectations for their students, enabled them to develop

math disciplinary language knowledge to provide explicit and practical feedback. Furthermore, a PD project on SFL pedagogy has highlighted the benefits of improved CLIL pedagogy (Llinares & Morton, 2010, 2017). Teachers should attend PD programs that focus on developing their knowledge of mathematical genres, registers, and multimodal symbols (Accurso et al., 2017).

4.6. Conclusion

This chapter presented the analysis of the qualitative questionnaire, documents, and interviews. It has also illustrated the emerging themes and findings across the data sets. Finally, it foregrounded the discussion of the results of the three research questions and the literature about translanguaging and SFL. In the following chapter, I will summarize the main findings, make recommendations for further research, and highlight some limitations that impacted the research project.

Chapter 5: Conclusion

The previous chapter focused on the analysis, discussion, and findings from three data sets: qualitative questionnaires, documents, and interviews offered triangulation to achieve reliability and validity of the research findings. These data collection tools illustrated the metalinguistic knowledge that mathematics teachers should have in EMI instruction for effective translanguaging practices in two Grade 10 classes. For this reason, the study investigated the metalinguistic knowledge that mathematics teachers would need to implement translanguaging as a pedagogical tool. In addition, it illustrated when and why these math teachers switch languages and how these switches contribute to the scaffolding of content and language.

In this final chapter, I foreground and summarize the main conclusions of the study, which were: (a) the metalinguistic knowledge that mathematics teachers need to draw on to use translanguaging as a pedagogical tool;(b) the main reasons for translanguaging;(c) the role of translanguaging in scaffolding content and language. Furthermore, this chapter presents the implications of the results, the study's limitations and provides recommendations for further research.

Metalinguistic Knowledge that Mathematics Teachers Need

Firstly, to draw on transformative translanguaging practices, teachers should be acquainted with different genres such as procedures/instructions and information reports. For example, two out of the four documents analyzed were associated with procedures, and one was a mixed genre while the other was an information report. They should also know mathematical registers related to the field, tenor, and mode. This type of knowledge is essential because it would enable them to move beyond the translation of terminology towards making explicit grammatical metaphors such as nominalization (equation, triangulation, addition, subtraction) that converts processes into nouns. In addition, knowledge of the mode dimension would allow these teachers to shed light on multimodality in mathematics because the discipline consists of linguistic, symbolic, and visual components that jointly negotiate meaning. Therefore, with the appropriate metalinguistic knowledge, teachers might make explicit how mathematics genres, registers, and discourses draw on semiotic tools such as vocabulary, symbols, and visuals to negotiate mathematical content.

Reasons for Translanguaging

The data illustrated that teachers' translanguage because of their students' needs. In Grade 8, they switch for both content and language because of the CLIL approach acting as a

gradual transition towards English-only content in later grades. In Grade 10, they switch language selectively to ensure that their students gain the knowledge associated with the content. Interestingly, the study also found that these teachers have positive affect and judgment towards EMI teaching and the use of their students' L1. Nonetheless, even though these teachers were flexible and made ample use of translanguaging strategies, they only translated subject-specific terms and words to teach the mathematical content.

Scaffolding Content and Language

As mentioned above, the study found that teachers practiced translanguaging that is only content-driven. Thus there is only minimal space for the scaffolding of math register and metalanguage. Therefore, translanguaging practices within this context are associated with translations and language switches to provide students with opportunities to make sense of math content. Thus, language scaffolding and the registers of mathematics were generally unexplored. Consequently, there is a need for explicit language scaffolding because it can expand students' language awareness and develop their mathematical register associated with reasoning, problem-solving, and their metalanguage to construct logical arguments.

5.1. Implications of the findings

The findings from the data sets hold several implications for education policymakers, school administrators, and mathematics teachers.

Education policy-makers should recognize that effective EMI and CLIL implementation requires more than just English language proficiency courses. For example, if STEM teachers have acquired the appropriate English language proficiency, then the next step should be developing their metalinguistic knowledge of the STEM disciplines. Therefore, PDs need to include training to scaffold the language and their subject's content explicitly. By

doing this, flexible language practices such as translanguaging might have transformative pedagogical implications. For example, teachers will be able to plan their language switches related to mediation and make visible the language codes of STEM subjects so that their learners can make sense of both the language discourse and the content. Also, it will help teachers to be selective in their translanguaging methods and provide a space for teaching both content and language simultaneously.

5.2. Recommendations for further research

The results of this study suggest that mathematics teachers need to have a solid understanding of how language works within their discipline. Thus, effective CLIL implementation would be challenging for teachers and their students without appropriate training and systematic support. Therefore, follow-up research should explore how in-service genre-based programs can equip mathematics teachers with the necessary metalinguistic knowledge and math subject literacies. Secondly, research should explore current translanguaging practices in longitudinal studies to inform future CLIL professional development. Finally, research should explore pre-service mathematics teacher education programs to shed light on how it includes subject-specific literacies, mathematics register, and multiliteracies discourses related to mathematics symbols and images.

5.3. Limitations

The scope of this study was the translanguaging practices in two Grade 10 mathematics classrooms. It only included two participants and one NIS school in an urban context in Kazakhstan. Therefore, this study was a small-scale research project that was relatively short, and due to Covid-19 restrictions, I could not conduct observations at the school. For this reason, the study could not shed light on the actual translanguaging practices

employed in these two classrooms. Therefore, the results of this study cannot be generalized due to the uniqueness of the research site and participants. Nonetheless, the study offers possibilities for exploring the translanguaging practices in STEM classes in greater depth, informing future CLIL professional development programs.

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Appendix A: Qualitative questionnaire

Purpose:

A. Personal details: Please indicate

1. Your gender
   - Male
   - Female
   - Other
2. Your age
   - 20-30
   - 30-40
   - 40-50
   - 50-60
3. Teaching experience
   - 2-5
   - 5-10
   - 10-20
   - 20-30

4. Your higher educational institutions

University/College	Degree: BA; MA; PhD	Major

5. Your school context

- NIS
- State mainstream school
- Have you ever trained in professional development programs? ***If yes,*** fill the blank with the name of the program.

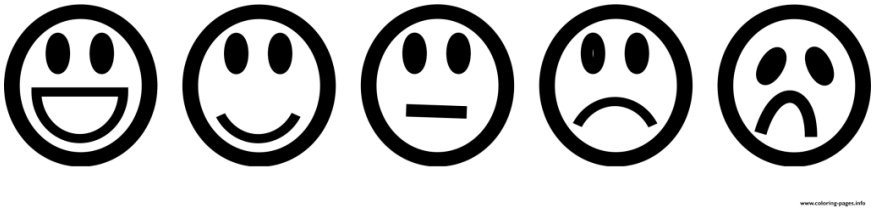
  _____

B. Languages in the classroom: Please indicate

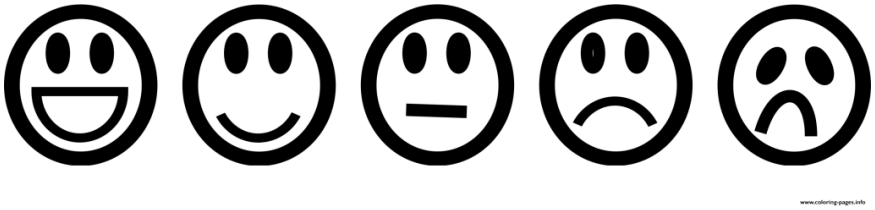
6. Your first language? (The language that you're speaking from birth)
- Kazakh
- Russian
- Other
7. Your students' first language/s
- Kazakh
- Russian
- Other
8. The current language of instruction in your class
- Kazakh
- Russian
- English
9. The language of instruction in your class before English
- Kazakh
- Russian
- English

C. Language and math learning

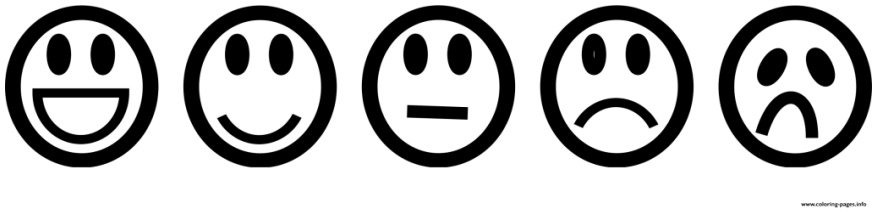
10. How do you experience teaching math through EMI?



11. How do you think? What do your students experience math learning through EMI?



12. Do you use Kazakh/Russian languages while teaching?
    - Yes
    - No
13. When do you use them?
    - instruction of activities
    - remind students' their behavior
    - mathematical concepts
    - I don't switch
14. Do you allow your students to switch to their L1?
    - Yes
    - No
    - Other (sometimes, rarely)
15. What is your opinion on using students' mother tongue (Kazakh/Russian) while teaching content?



Анкета

Цель:

A. Личные данные: Пожалуйста укажите

1. Ваш пол
   - Мужской
   - Женский
   - Другой
2. Ваш возраст
   - 20-30
   - 30-40
   - 40-50
   - 50-60
3. Опыт преподавания
   - 2-5 лет
   - 5-10 лет
   - 10-20 лет
   - 20-30 лет

4. Высшие учебные заведения в которых вы обучались

Университет/Колледж	Степень: Бакалавр; Магистр; Кандидат наук	Специальность

5. В каком из ниже указанных школах вы преподаете?
   - NIS
   - Государственная общеобразовательная школа

6. Вы когда-нибудь обучались по программе повышения квалификации? (***Если да,*** укажите в поле название программы.. ***Если не проходили,*** пропустите вопрос)

   _____

B. Языки: Пожалуйста укажите

7. Ваш родной язык? (Язык, на котором вы говорите от рождения)
   - Казахский
   - Русский
   - Другой
8. Родной/ые язык/и ваших учеников
   - Казахский
   - Русский
   - Другой

25. Текущий язык обучения в вашем классе
   - Казахский
   - Русский
   - Другой

26. Язык обучения в вашем классе до внедрения английского
   - Казахский
   - Русский
   - Другой

C. Изучение языков и математики

9. Как вы относитесь к преподаванию математики на Английском языке?

10. Как ваши ученики относится к обучению математики на Английском языке?

11. Используете ли во время обучения казахский / русский языки??
    - Да
    - Нет
    - Когда вы их используете?
    - при описаний заданий
    - что бы напомнить ученикам об их поведении
    - для математических терминов
    - Я не использую другие языки кроме Английского
12. Разрешаете ли вы своим ученикам использовать свой родной язык?
    - Да
    - Нет
    - Другое (иногда, редко)
13. Как вы относитесь к использованию родного языка учащихся (казахский / русский) при преподавании материалов?

Сауалнама

Мақсаты:

А. Жеке деректер:

1. Сіздің жынысыңыз
   - Ер
   - Әйел
   - Басқа
   - Сіздің жасыңыз
   - 20-30
   - 30-40
   - 40-50
   - 50-60
2. Оқыту тәжірибесі
   - 2-5
   - 5-10
   - 10-20
   - 20-30

3. Сіз оқыған жоғары оқу орындары

Университет/Колледж	Дәреже: Бакалавр; Магистр; ғылым кандидаты	Мамандық

4. Төмендегі мектептердің қайсысында сабақ бересіз?
   - NIS
   - Мемлекеттік жалпы білім беретін мектеп
5. Сіз білім беру бағдарламасына қатысып көрдіңіз бе? (Егер қатысқан болсаңыз, бос жолға бағдарламаның атауын жазыңыз. Егер қатыспасаңыз, сұрақты өткізіп жіберіңіз)

   _____

6. Сыныптағы тілдер:

7. Сіздің ана тіліңіз қандай? (Сіз туғаннан сөйлейтін тіл)
   - Қазақ
   - Орыс
   - Басқа
8. Оқушыларыңыздың ана тілі/дері
   - Қазақ
   - Орыс
   - Басқа
25. Сіздің сыныбыңыздағы оқыту тілі
   - Қазақ
   - Орыс
   - Басқа
26. Ағылшын тілінен бұрынғы сіздің сыныбыңыздағы оқыту тілі
   - Қазақ
   - Орыс
   - Басқа

9. Тілдер мен математика пәнін оқып үйрену

10. Жаратылыстану пәнін ағылшын тілінде оқытуға қалай қарайсыз?

11. Сіздің оқушыларыңыз математика пәнін ағылшын тілінде оқытуға қалай қарайды?

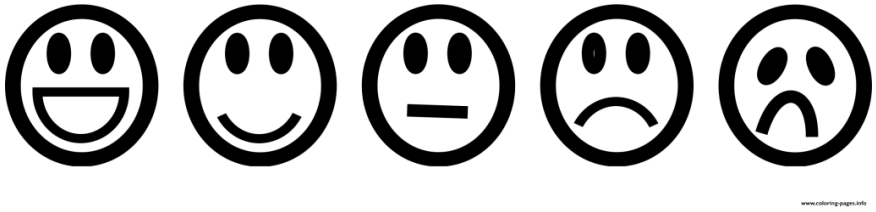
12. Сіз оқу барысында қазақ / орыс тілдерін қолданасыз ба?
- Ия
- Жоқ

26. Сіз оларды қашан қолданасыз?

- тапсырмаларды сипаттау барысында
- оқушылардың мінез-құлқын есктеріне түсіруге
- математика терминдерін түсіндіруде
- Мен ағылшын тілінен басқа тілдерді қолданбаймын

13. Оқушыларыңызға өз тілдерін қолдануға рұқсат бересіз бе?
- Ия
- Жоқ
- Басқа (кейде сирек)

14. Сабақ материалдарын оқыту барысында студенттердің ана тілін (қазақ / орыс) қолдануына деген көзқарасыңыз қандай?



Appendix B: Document analysis framework

Purpose: To provide a clear set of directions for completing a specific task

How is Language used in the document to achieve the purpose?	
Structure	
Audience Relationship with audience	
How is Language structured for use to achieve its purpose?	
Field	Noun phrases and process, circumstances
Tenor	Mood: Modality:
Mode	Written, Spoken, Multimodal

Appendix C: Interview questions

1. Describe one of your mathematics classes.

2. What language plays the most significant role in your mathematics class, and why?

3.How are you experiencing mathematics classes through EMI?

4. How do you think your student is coping with mathematics learning in English?

5.What advantages do the EMI offer (if any) for you and your students?

6.What challenges do the EMI offer (if any) for you and your students?

Probe question: *How does your school perceive this practice?*

1. Математика сабақтарыңыздың бірін сипаттаңыз.

2. Сіздің математика сабағыңызда қай тіл маңызды рөл атқарады және неге?

3. Ағылшын тілінде математика сабақтарын қалай өткізесіз?

4. Оқушыларыңыздың математика сабақтарын ағылшын тілінде орындауға шамасы жетіп жатыр деп ойлайсыз ба?

5. Сіздің ойыңызша сізге және сіздің оқушыларыңызға ағылшын тілінде оқытудың қандай артықшылықтары бар (егер бар болса)?

6. Ағылшын тілінде оқыту сізге және сіздің оқушыларыңызға қандай мәселе туғызады (егер бар болса)?

Қосымша сұрақ: *Сіздің мектебіңіз бұл тәжірибені қалай қабылдайды?*

1. Опишите один из ваших занятий по классу математики.

2. Какой язык играет наиболее важную роль на вашем уроке математики и почему?

3. Каковы ваши ощущения по поводу преподавания математики на английском языке?

4. Как, по вашему мнению, ваш ученик справляется с изучением математики на английском языке?

5. Какие преимущества предлагает обучение на английском языке (если таковые имеются) для вас и ваших учеников?

6. Какие проблемы доставляет обучение на английском языке (если есть) вам и вашим учеников?

Дополнительный вопрос: *А как ваша школа воспринимает эту практику?*