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How do Arab Students in Higher Education Institutions Perceive the Influence of Mother Tongue Mastery on Their Mathematical Skills Development and Performance

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Abstract
This research examines and analyzes how Arab students enrolled in higher education in Israel view the effect of mother tongue mastery on their development of mathematical skills and academic outcomes. This research was undertaken to discuss the ongoing concerns that students face with cognitive, academic, and emotional impact after learning mathematics in another language (i.e. Hebrew). The research employed qualitative methodology involving semi-structured prompted interviews and focus groups with 45 first-year Arab students. The data from this research shows students who had a better command of their mother tongue did understand better and had more confidence in their ability from the outset, which was noted by very high academic performance in pedagogy and mathematics. Major findings reveal using a mother tongue influences cognition processing and problem-solving and that second-language instruction could produce emotional barriers and barriers in understanding. Overall, the study recommends supporting mother-tongue instruction, encouraging translanguaging practices, and developing culturally responsive pedagogical materials. The recommendations will provide support for theories in language-cognition relationships and offer practical considerations for promoting educational equity and improvements to learning outcomes for linguistically marginalized students in multilingual locales.
Keywords: *Mother tongue, Mathematics education, Arab students, Higher education, Language of instruction, Translanguaging, Bilingualism, Cognitive development, Educational equity,Israel.*

1. INTRODUCTION

This research examines how Arab students enrolled in higher education institutions in Israel understand the role that mastery of their mother tongue has had on their learning and performance of mathematics. The key objective is to further examine the cognitive, academic, and socio-emotional processes associated with learning mathematics from either the students' first language or a second language, usually Hebrew. The research addresses a total of five research questions that assess the relationships between the mastery of a mother tongue and mathematical skill acquisition, comprehension, academic performance, challenges with learning in a second language, and coping strategies on the part of students. By employing a qualitative methodology, semi-structured interviews, and focus groups, this study enhanced the understanding of the complications of language on content learning and practice proffer some important suggestions for policy and practice. The key findings showed that students who utilized their mother tongue in a mathematical context tended to perform better, think more clearly, and felt more academically competent. Furthermore, what this research showed was that second language instruction has detrimental effects for learning, but that translanguaging was an extremely common student approach.

Here, the term "mother tongue" refers to the first language learned from infancy onward and the language that is used most naturally for communication, thinking, and learning (UNESCO, 2003; Swanson et al., 2019). "Translanguaging" is also an important concept in this research project which was use in reference to the multimodal process in which multilingual learners respond cognitively to learning, in terms of how they strategically use their whole linguistic repertoire (García & Lin, 2016). Although the study population is Arab first year university students in Israel, the language situations the respective learners are dealing with has many layers of challenge to the task of learning mathematics that has specific vocabulary, logical relations between concepts and dialectical reasoning. For this reason, this study investigates specifically the relationship between students' mastery of language and their learning of mathematic noteworthy enough as a subject with academic and policy significance.

The significance of this research is that it is able to demonstrate the educational inequities resulting from second or third language instruction in higher education for linguistically minoritized students. Previous research by Heugh and others (2007), Begum and others (2024), and Bialystok (2018) have pointed out how teaching a student in their first language will facilitate cognitive process and therefore assist with their education attainment. In Israel, many Arab learners receive math education in Hebrew as the

language of instruction and receive no or little linguistic support (Hibi, 2022.). Findings of this study reflect the international literature around linguistic discrimination and working memory over-load while learning mathematics and math concepts in a second language (Ní Ríordáin et al., 2024; Dervić & Bećirović, 2019). Adopting a qualitative research methodology (Creswell & Poth, 2018; Silverman, 2020) allows for the participants to share the subtleties of their voices and reveal their lived experiences of the 45 Arab identified students. Recommendations from the results suggest increasing support for mother-tongue based instruction and translanguaging in the classroom, as well as the creation of culturally- and linguistically- appropriate math instruction. All recommended actions will greatly increase equity, understanding, and success in math education of an Arab student in Israel.

2. LITERATURE REVIEW

2.1 Mother Tongue as Medium of Instruction

Mother-tongue instruction refers to the aspect of early child education in which a child's first language—the language that is likely to be the most familiar, spoken more frequently at home—serves as the main language of instruction (Ekeh, 2020)). Mother- tongue instruction encapsulates both the teaching of any school subject (apart from foreign languages like English) in a child's target local language, as well as the use of the mother tongue to support understanding and to explain ideas and difficult concepts in subjects taught in another language (Xu, 2018). UNESCO (2003) states that a child learning through their mother-tongue is learning by connecting new knowledge with familiar cultural references and linguistic structure, framing mother-tongue instruction as a key feature of educational quality related to early childhood development (UNESCO, 2011).

Research has repeatedly demonstrated that children who receive education throughout their foundational years in their mother-tongue develop stronger literacy, cognitive, and problem-solving skills than through other methods of schooling (Nishanthi, 2020). According to Begum and others (2002), students in bilingual programs who begin instruction in their mother-tongue outperform their peers over the long haul—both in grades and educational outcomes (Nieto, 2020). In a study of the Ethiopian education system, Heugh et al. (2007) reported that learners taught in their first language for longer periods of time demonstrated a higher level of achievement compared to students transitioned early to a second language of instruction. Van Raemdonck (2024) and Jusslin and others (2022), through studies in multilingual contexts similarly build arguments based on educational research completed across several decades supporting the cognitive and emotional benefits of learning through one's first language.

2.2 Mathematics and Mother Tongue

According to Israel & Thomas (2013) when children are taught mathematics using their mother tongue comprehend mathematics better. Learning mother tongue also helps to improve mathematical vocabulary that could be easily used and remembered by students within the community at large (Bermejo, et al., 2021). The use of Mother Tongue (MT) as a medium of instruction is globally recommended for pupils in lower primary schools. Mother tongue is the language a child learns first from the mother or the principal caregiver. It is one's native language. (Englis & Boholano, 2021). It is a language acquired in early childhood and spoken with native speaker competence and it is the language a person is exposed to and acquired during years of childhood (Swanson, et al., 2019). A child 's mother tongue should be used as a medium of instruction in learning in grades 1-3, because the fundamental Math and Science concepts are introduced at this level. Englis, and Boholano (2021) stated that mother tongue enables a child to express himself/herself easily, as there is no fear of making mistakes. Bialystok (2018) added that children taught in mother tongue have better learning comprehension than those taught in a foreign language. Omoniyi, Olabode and Thomas (2020) stated that Mathematics taught in a child 's mother tongue has benefits such as overcoming limited knowledge of foreign mathematical vocabulary and brings children closer to Mathematics. Moreover, children who enter school and begin learning in a new language before they completely understand their first language, face much trouble or difficulty in confrontation of new ideas in the second language. Ultimately, it is very difficult for a child to do well as a language minority student without having a solid foundation in his/her first language.

According to Odiba and his colleagues (2014) pupils do not make a lot of progress in mathematics due to their inability to understand the language of instruction and further remarks that mathematics is a nightmare for many pupils and has created a mathematics fever. Research carried out on mother tongue has revealed that learners find it easier to read and acquire other academic skills when instruction is in the home language than when they are taught in a foreign language (Cerezci, 2020).

Another study by Fakeye (2011) revealed that a medium of instruction is the language used in importing

knowledge and inculcating cultural values, practices and norms of the society/community in the young ones in the formal schools system.

Moreover, Rajathurai (2020) stated that, mother tongue in classrooms enable children to express themselves, contribute to discussions and develop their intelligence as conversations are carried out in a familiar language. Instruction given in a language that learners do not speak is called submersion. Mother tongue is an essential foundation for children who enter school at first time. Furthermore, in order to gain interest in mathematics and make meaning out of what children are learning, their culture needs to be embedded in mathematics. Pupils taught how to read and write in their first language acquire the context faster.

The majority of the Arab youngsters and adolescents in Israel are bilingual in Palestinian Arabic and Israeli Hebrew. Yet a great number of them are far from being native speakers of either Israeli Hebrew or literary Arabic. Linguistically, the Palestinian-Israeli section has three languages in addition to spoken Arabic, literary Arabic, Hebrew and English. In some private schools French can be added. Moreover, teachers of mathematics and physics in secondary schools often use Hebrew. The textbooks of such subjects are usually in Hebrew or poorly rendered from Hebrew into Arabic (Shehadeh, 2019).

3. MATERIAL AND METHODS

This study was designed as a qualitative study because the researcher was interested in students' attitudes, thoughts, and meaning of their first language, and the connection between their mother tongue and their ability to learn mathematics. Qualitative research provided an opportunity to hear real voices and real stories of the students. Creswell and Poth (2018) state that qualitative research addresses the complexity of human experience, where context and meaning can be important. Language and learning are very personal, so a qualitative research plan felt the most appropriate to our study purpose (Silverman, 2020).

To access the information needed, two conventional tools (one-on-one semi- structured interviews, and small focus group discussions) were used. Interviews were conducted with a total of 20 students as they were asked open-ended questions and were given the space to share their perspectives freely while still keeping things tied to the main questions of the study. Additionally, 25 students participated in five focus groups with five participants. The focus groups brought forward some salient conversations and group interactions that would have been completely different environments had the students participated in one-on-one interviews alone. DeJonckheere & Vaughn (2019) describe that the semi-structured interviews are valuable for achieving consistency and depth, while Guest and others (2017) describe focus groups as useful for exploring collective experiences, and discovering commonalities and patterns.

The sample used in this study consisted of Arab students attending bachelor's degree programs at Israeli higher education institutions. Participants were recruited using a purposive sampling strategy that allowed the researcher to capture a very specific group of Arab students who had recently transitioned from high school to university (Memon et al., 2025). As a result, 45 first-year students were recruited because they were best positioned to share their perspectives on their school-based and precocious university mathematics learning experiences. The sample was considered purposeful based on participants' ability to reflect on language-related obstacles in learning mathematics in accordance with the definition set out in the study by Palinkas and others (2015) on purposeful sampling in qualitative research focused on a phenomenon.

All qualitative data were analyzed using reflexive thematic analysis as outlined by Braun and Clarke (2022). Thematic analysis consisted of six steps: familiarization with the data, generating initial codes, identifying potential themes, reviewing thematic map, defining and naming themes, and final write-up. Thematic analysis allowed the disparate individual narratives to be organized into coherent themes in response to the research questions (Finlay, 2021). During all analytic stages reflexivity was used to address potential researcher bias, and ensure that the findings accurately represented the participants' views and were produced through a clear, consistent and robust process (Alordiah, 2025).

4. RESULTS

The following results present the key themes that emerged from the voices of Arab students in higher education regarding how mastery of their mother tongue influences their learning and performance in mathematics. These findings reveal that the native language serves not only as a foundation for developing mathematical skills but also as a cognitive tool for processing and solving problems. The themes also highlight the academic advantages of learning in the mother tongue, the emotional and

linguistic challenges of studying in a second language, and the adaptive strategies students employ—such as translanguaging—to navigate these challenges and enhance comprehension in a multilingual educational setting.

Theme 1: The Link Between Mother Tongue Mastery and the Development of Mathematical Skills

The participants pointed out that foundation in their mother tongue is equally important to developing an understanding of mathematics. One student mentioned, "When they taught math in Arabic, I understood what the formulas even were - it wasn't just figuring out to memorize." Another reiterated this by saying, "Once it was Hebrew, I felt like I had to translate everything in my head first and then try to solve it." These reflections demonstrate the cognitive burden students have when the language is not matched with their previous learning. Heugh and others (2007) noted that students who had instruction in their first language in their fundamental years develop more cognitive and academic abilities, even in mathematics, while Barbaran and others (2025) found that students who received instruction in their mother tongue, after a certain number of years of learning, achieved better academic performances overall, suggesting that fundamental, early language foundations contribute to skill acquisition.

Theme 2: Perceptions of the Role of Mother Tongue in Understanding and Solving Mathematical Problems

Students described the mother tongue as a tool for making sense of abstract problems. One student described, “There are times I don’t understand the Hebrew terms in the question, but once I say it in Arabic, it becomes much clearer and easier to solve.” Another student said, “Thinking in Arabic helps me figure out and solve the problem—it’s like I build a picture in my mind.” As these excerpts illustrate, language is not just a medium of instruction, it also serves as a frame of cognitive processing. El Shennawy and Teba-Fernández (2021) support this with the interdependence hypothesis, where the conceptual frameworks for the knowledge learned in language one can easily be transferred to language two, providing the learner has a strong foundation in language one. Smit and others (2023) also found that students rely on their first language for internal processing and reasoning, more so in mathematics and subjects with problem-solving demands..

Theme 3: The Influence of Mother Tongue on Academic Performance in Mathematics

Students consistently reported that their academic performance in mathematics was better when their mother tongue was used in instructional and study materials. One student stated, “My best math grades were when I was in high school when the teacher explained in Arabic. At university, it became more challenging when it was only in Hebrew,” and another said, “Even when studying now, I look up Arabic ones on Youtube because they are easier for me." These comments align with Shaddad and Jember (2024) conclusion that learning a familiar language reduces attrition and increases student engagement and academic performance as students negotiate and navigate school learning and new ideas and concepts. Based on what we previously discussed, UNESCO (2025) has indicated that learning through one’s language is not only better for understanding but also promotes learning in the long term, especially in multi-lingual education settings.

Theme 4: Challenges of Learning Mathematics in a Non-Native Language

Several participants noted linguistic barriers was also one of the key obstacles that they encountered when learning mathematics. One student said, “I get the math itself but the problem is with the language—it makes it hard to follow what the lecturer means.” Another said, “If I want to ask a question in class, I am hesitant to do so because I do not feel confident in Hebrew, and I don’t want to misunderstand.” These concerns represent the emotional and academic burden of learning in a second-language. Dervić and Bećirović (2019) suggested that teaching without a learner's native language in the classroom could be viewed as form of educational discrimination and leads to reduced confidence and possibility for learning. Moreover, Ní Ríordáin and others (2024) referred to language learning about learning in schools as an unfamiliar language landscape thus creating learning limitations and barriers on participation within formal systems of learning especially in a technical subject like mathematics..

Theme 5: Strategies Used to Leverage the Mother Tongue for Mathematical Understanding

Despite difficulties encountered during the semester, students indicated they were using their mother tongue actively as a strategy for improving their comprehension. As one student explained, "I first write the notes in Arabic, and then translate them to Hebrew; it makes me learn it twice." Another student noted, "We study in Arabic in our group; and we try to write the answers in Hebrew." These strategies reflect resourcefulness and a desire to bridge linguistic gaps. Jawad (2021) noted that students often

employ bilingual strategies to comprehend content more fully, particularly in bilingual or multilingual systems that are not using home languages as the medium of instruction. Likewise, García and Lin (2016) shared perspective on translanguaging practices when students draw from their entire language resources to make meaning and sense of their educational experience, especially true in multilingual education systems.

5. DISCUSSION

This study's findings emphasize the dominant role of mother tongue proficiency in forming Arab students' experiences with, and attitudes towards, mathematics at higher education institutions in Israel. The study showed that language is not just a means of communication; it is indicative of how learners think, reason, and problem- solve in a formal and cognitive way—this identification or recognition may be particularly relevant in mathematically and/or cognitively demanding subjects like mathematics (Espinas & Fuchs, 2022; Turan & De Smedt, 2022; Wilkinson et al., 2018). The findings provide an additional view on the overlap between linguistic background and academic achievement, and reinforce the value of mother tongue - based instruction with marginalized or bilingual communities, who may have experience and understanding of an educational system which operates in a second or third language. The experiences described by the participants correspond with the trends which have consistently been highlighted in international research literature, and this holds both local and transferability implications for educational access, equity, and language policy.

A key finding from the research was that learners with strong skills in their mother tongue had a more robust development of their mathematical skills. The participants explained to the researchers that concepts generally became easier for them to grasp when they first learned them in Arabic, whereas learning them in Hebrew brought in additional cognitive load which interrupted their fluency in solving problems. Overall, these findings are consistent with earlier findings of Heugh and others (2007) which propose that learners with sound skills in their first language demonstrate increased cognitive and academic achievement in subjects, including Mathematics, when their first language is used during their foundational years. Barbaran and othes (2025) provided additional support, showing that learners who utilized their mother tongue in their academic instruction demonstrated suddenly better academic performance as a foundational language of instruction. The evidence appears to support that early on developing cognitive and conceptual aspects of mathematical thinking at home in the same linguistic mode of the language of instruction at school seemed to be of great linguistic importance.

Another crucial lesson from the research is centered on the function of the mother tongue in understanding and cognition. The students said that mentally switching to Arabic allowed them to unpack difficult problems, reorganize the process of equations and unpack the mathematical logic much quicker. This resonates with Perkins and Zhang's (2024) interdependence hypothesis indicating that knowledge learned in the first language can be accessed and transferred to a second language where the first language is well developed. El Shennawy and Teba-Fernández (2021) have similarly found, and Smit and others (2023) identified that students will retain their native language in their abstract reasoning when faced with demanding tasks such as mathematics. These findings emphasize that language is not separate from content learning; rather, it supports the cognitive platform of connecting with academic work meaningfully.

The relationship between mother tongue use and actual academic performance in mathematics was also prominent. The participants made frequent reference to their better grades and confidence when learning occurred in Arabic, in contrast to the struggle of learning at the University where Hebrew was the language for instruction. These findings resonate with Shaddad and Jember's (2024) findings that learning in a familiar language increases academic engagement and reduces risk of dropping out. Furthermore, UNESCO (2025) calls attention to the long-lasting benefits of learning in an individual's mother tongue that is especially common for many refugees and in multilingual and multicultural spaces, finding that learning in the mother's language improves comprehension and retention while contributing positively to one’s emotional state. The study provides further indication of the importance of mother's language where students are not only more successful but feel more secure, when their language identity is recognized and supported in the learning process.

Conversely, the research also provided evidence for the ongoing tension students encounter when learning about mathematics through a different language. The participants conveyed experiences of language confusion and emotional discomfort participating in the classroom and the assessment processes. These experiences reflect educational research on the restrictive nature of instruction in a

foreign language cultivated on students' level of participation and comprehension in mathematics classrooms (Ní Ríordáin et al., 2024). Dervić and Bećirović (2019) even contend that the exclusion of learners' native language from instruction constitutes hidden discrimination that functions to limit the accessibility of full engagement in an academic context. This research offers further support that language barriers can inhibit academic confidence in a classroom environment cultivate silence and disengagement, particularly for bilingual students in higher education settings, which may be predicated on a dominant language.

Despite the challenges faced, students were demonstrating considerable agency by using their mother tongue strategically to work their way through language challenges. For instance, multiple students reported using Arabic, their mother tongue, to make notes, reflect upon lessons, and to work with their classmates who were also using their mother tongue to collaboratively arrive at Hebrew responses. These bilingual strategies are examples of adaptive learning behaviors by students and allow translanguaging and translanguaging practice. García and Lin (2016) define translanguaging as the ways in which students draw onto their entire language repertoire when working through ways to understand or communicate in English for academic purposes. Similarly, Jawad (2021) found in her study of students within bilingual systems of education that students would always use their mother tongue despite it being unsupported, to scaffold processing and engagement with educational content. The current study supports these findings, and found that where students are permitted or encouraged to use all the language resources available to them, their learning experience is more equitable and effective.

6. CONCLUSION

This research has found that mastery of the first language is a pivotal element in shaping Arab students' perceptions and experiences when learning mathematics in higher education institutions in Israel. The evidence consistently demonstrated that Arab students who were learning mathematical concepts in their first language had clearer understanding, higher confidence, and greater success in academic mathematics courses. The evidence also demonstrated that language was more than just a form of communication; it was very much tied to mental processes such as problem-solving, logic, and reasoning. The thematic focus of the research includes the critical role of early mother tongue teaching, enhanced cognitive processing when problem-solving in the mother tongue, enhanced academic performance by engaging the mother tongue, challenges students experience when engaging in learning through a second language, and the cognitive flexibility students demonstrate in negotiating their language barriers.

The synthesized data showed that students mainly utilized their first (native) language to conceptually organize, structure, and understand mathematical content, which confirms theoretical perspectives stemming from Cummins' (1981b) interdependence hypothesis (El Shennawy & Teba-Fernández, 2021; Smit et al., 2023). After all, when content in a learner's mother tongue is disadvantaged by being learned in Hebrew or any other second language, learners are engaged in learning, representing, and problem solving, emotionally and cognitively in an alternative language with emotional and cognitive limitations, which can create barriers to engagement, participation, and academic success (Dervić & Bećirović, 2019; Ní Ríordáin et al., 2024). Therefore, using multiple translanguaging strategies (García & Lin, 2016), the resilience and creativity by students to manage their participation in a linguistically complicated academic setting were observed. Our results not only supported the incorporation of a mother's tongue approach in math education but also implied structural inequities being experienced by students who were not accommodated in their establishment of their linguistics identities.

While this study provided an abundance of insight, many questions remain unanswered. This study did not investigate the role of teachers or institutions in either supporting or suppressing the use of students' mother tongues, nor did the study consider longitudinal effects on students' success. Additionally, the study was conducted with a handful of first-year students, and more longitudinal studies are needed to determine how the processes of linguistic evolution and change play out over a university experience. Future studies could examine how proposed policy change, bilingual instructional models, and culturally responsive pedagogy can lead to a more equitable classroom experience. Ultimately, this study demonstrated that incorporating students' mother tongues into their education is both pedagogically important and a matter of educational equity, cognitive accessibility, and student wellness.

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