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The effects of language and home factors on Lebanese students' mathematics performance in TIMSS

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Abstract
Understanding the long-standing educational inequities associated with socioeconomic status remains significant for transforming educational policies and practices. To better understand entanglements among socioeconomic status and students' performance in mathematics, we examined different home factors (including language of the test) that influence Lebanese learners' performance in TIMSS. Exploring TIMSS data can assist us in identifying areas and groups of students who require additional assistance in order to address inequities. The purpose of this study is to investigate how language and other home factors influence Lebanese students' mathematics performance in TIMSS. Mathematics is taught in a foreign language (English or French) in Lebanon, according to Language of Learning and Teaching policy (LoLT) that dates to 1926. Using TIMSS data and hierarchical linear modeling (HLM), we looked at how students performed in mathematics based on the language of the test and how often they spoke it at home. Other home factors such as parents' education level, number of books owned, and parents' involvement were also examined. Results show that not speaking the language of the test at home and other SES-related factors had different but mostly significant contribution to students' mathematics scores. Lebanese students' overall low performance suggests the time is ripe for a reformed Lebanese curricula that responds to the needs of learners and of society, taking into consideration students' cultural capital and language of instruction.

Keywords Language and Mathematics, Cultural capital, International assessments, Language of instruction, TIMSS

Introduction

In today's scientific and technological age, advanced mathematical literacy is central for societies' growth and well-being and for preparing youth for future challenges and competitive careers. Mathematical literacy entails not only understanding and using concepts, but also developing the discipline's discourse and reasoning, and understanding that mathematics exists in a real world impacted by politics, economics, and social factors (Lemke, 2001; Moje, 2015). Lebanese students' steadily declining performance in mathematics raises general concerns on the quality of mathematics education in Lebanon, and in particular for students from lower socio-economic strata (SES) (Post et al., 2011). Indeed, since 2007 the Trends in International Mathematics and Science Study (TIMSS) examinations show that, not only did Lebanon's mathematics average decline, but has also been consistently lower than the TIMSS' Intermediate International Benchmark of 475 (Mullis et al., 2020); which indicates that Lebanese students are able to apply basic mathematical knowledge in simple situations rather than solve complex problems (Mullis et al., 2020). Moreover, the first author has found that students in private schools (usually the more affluent) performed significantly better in mathematics than students in public schools in TIMSS 2007 (Younes, 2013), which indicates educational inequalities based on students' SES. To better understand entanglements among dimensions of SES and students' performance in mathematics, we examined different home factors (including language) that influence Lebanese learners' performance in TIMSS. Lebanon is a theoretically significant case study for examining and acknowledging the nuanced and vital student's cultural and language capital and its role in students' development of advanced mathematical literacy. Around 65% of Lebanese students attend private schools (Center for Educational Research and Development (CERD), 2020); these schools though vary widely in terms of tuition fees and available resources (e.g., tuitions can range from free to very high tuition-fee elite schools). Students from lower socioeconomic strata attend public schools or less equipped private schools with lower or free tuition, whereas their more affluent counterparts attend medium to high tuition private schools. Moreover, Lebanese students learn mathematics in a foreign language (English or French) based on a Language-in-Education policy that dates back to 1926. Considering the proficiency in the target foreign language is yet another dimension of economic advantage, we also explored the influence of the language of the test on Lebanese TIMSS mathematics performance.

Theoretical Framework

A sociocultural perspective emphasizes the influence of societal, home and school culture, and language on learning and development (Vygotsky, 1983), with more recent sociocultural theories scrutinizing the central role played by social and power structures and hierarchies in education and educational systems. Accordingly, we draw on Bourdieu's concept of cultural capital and how languages and forms of languages become symbols of power or linguistic capital (Bourdieu, 1999). Bourdieu' social critical theory proposes that agency and access are subject to constraints set by social and power structures. Particularly, Bourdieu suggested the concept of 'cultural capital,' which involves familiarity with a society's dominant culture, and "the ability to understand and use 'educated' language" (Sullivan, 2001, p. 893). Indeed, Bourdieu (1999) adds that modes of transmission of linguistic capital between generations represents a particular case of modes to legitimately transmit cultural capital between generations, with "two principal factors of production of the legitimate competence, namely, the family and the educational system" (p. 62). Hence, educational systems become arenas for social class reproduction, and so educational quality along with language-in-education policies and how they are implemented can contribute significantly to either widening or narrowing the gaps among different factions in society (Bourdieu & Patterson, 1977). As such, language-in-education policies are intertwined significantly with political, socioeconomic, ethnic, and power structures, and consequently dominate schooling and access to quality educational experiences.

Home assets and mathematics performance

The intricate associations among home assets as SES indicators and TIMSS mathematics performance has been tackled in several studies. In their study on 4th grade mathematics performance in TIMSS 2015 in Turkey, Ersan and Rodriguez (2020) included a home resource for learning index to predict mathematics achievement. This index included parents' education and work, number of books at home, internet access, and whether the student owned their own room. Home resources for learning was a strong predictor of mathematics achievement and explained 7% of the variance within schools.

Parents' education level has been associated with students' performance in mathematics in several locations around the world (Ismail & Awang, 2008; Baliyan et al., 2012; Farouk et al., 2012; Kodippili, 2011). In his study on US 8th grade students, Kodippili (2011) found that, on average, a student whose parents had a university degree or higher scored 21 points more than a student whose parents only finished secondary school. Likewise, Ismail and Awang (2008)'s Malaysian study on 8th grade students, using TIMSS 2003, found that children whose parents had at least a post-secondary education, had a bigger chance of scoring higher in mathematics. Similarly, Farouk et al. (2012)'s study on secondary school students in Pakistan showed mothers' education level and fathers' education level affected their child's performance in mathematics differently. Fathers' education only significantly affected students' academic performance in mathematics if they had a bachelor's or master's degree while mothers with intermediate, secondary or bachelor's degree had significant effects on their children's academic performance in mathematics.

In their study on 32 countries, Huang and Liang (2016) showed that not only parental education had a significant relationship with students' performance in mathematics but also book possession and parental expectations for their children. Educational resources and the availability of books/reading materials at home have a role in determining how far students go in schooling (De Graaf et al., 2000; Teachman, 1987). Teachman (1987), used four items to measure the educational resources found at home: a specific place to study, availability of reference books, a daily newspaper, or a dictionary/encyclopedia. Likewise, Ismail and Awang (2008) found that 8th grade students who own books or use computers regularly scored significantly higher in mathematics. Specifically, the use of computers had the highest probability of students in Malaysia scoring above the international mean and students who had one or more bookcase were "three times more likely to score above the international average" (p. 38). Furthermore, according to De Graaf et al. (2000), parental reading behavior plays a positive role in their children's education careers. Their study found that parental education was the most powerful predictor of children's educational attainment in the Netherlands. Based on the research presented in these studies, it can be concluded that home resources including parental education have significant impact on students' mathematics performance. The research demonstrates that the presence of books, internet access, supportive parental behaviors, and a conducive learning environment to study at home are all associated with better student's academic outcomes. Therefore, policymakers and educators should consider ways to increase access to educational resources for students, especially for those who come from disadvantaged backgrounds. This may involve providing educational resources to families and promoting parental involvement in their children's education.

Language and mathematics performance

From a sociocultural perspective, language is a significant cultural tool for co-constructing meaning and higher levels of mathematical knowledge (Fernandez, 2023; Moschkovich et al., 2018) where communication and developing mathematics academic discourse are a central component of mathematics teaching and learning (Schleppegrell, 2007; Moschkovich et al., 2018). Contrary to the traditional belief that mathematics is less reliant on language as compared to other subjects, it is increasingly acknowledged that language assumes as significant a role in the learning of mathematics as in the learning of the other subjects (Moschkovich, 2018). Based on the principles and standards of the National Council of Teachers of Mathematics (NCTM, 2000), students are not only required to develop mathematical understanding, reasoning, and problem solving, but they also need to develop the mathematical language to formulate conjectures and justify their thinking verbally and in writing (Fernandez, 2023). Indeed, students need to be able to "organize and consolidate their mathematical thinking through communication," and "communicate their mathematical thinking coherently and clearly to peers, teachers, and others" (NTCM, n.d.). When learners get to use language meaningfully using both every day and mathematics registers to discuss, analyze and explore their own reasoning as well as the reasoning of others, they develop as 'powerful mathematical thinkers' (Assaf & Graves, 2019). This shows that language plays an essential role in the construction and development of conceptual understanding and critical thinking skills, thus the need of a language-rich environment.

The Lebanese context

The educational system in Lebanon is trilingual with mathematics and science taught and assessed in an international language (English or French). Almost all private and public schools teach mathematics in a second language (L2), either in French or English, starting from kindergarten all the way through high school. A small number of schools, particularly in rural areas, use Arabic (L1) for teaching mathematics in grades 1 through 6, and later shift to using L2 after grade 6 (El Mouhayar & Jurdak, 2013). Lebanon's language-in-education policy is rooted in the country's history [1] and the independence of modern Lebanon (1946) with an economy reliant on commerce and tourism: Using L2 in mathematics instruction is believed to develop students' mathematics curiosity and give them access to worldwide resources while being aligned with the language of instruction adopted in a wide range of universities (Dandashly, 2014). Parents usually decide whether they would like their children to be in the English or French track. There is almost an even distribution of students between French or English-medium schools: students in French-medium schools comprise 49.6% of the student population and the English-medium schools 50.4% (CERD, 2020).

Mathematics achievement in Lebanese schools, though, has been steadily declining in the last three decades (Chahine et al., 2011), with the rate of success in official examinations not surpassing 60% in 2007 (Chahine, 2011). In addition, most Lebanese students

[1] Foreign missionary schools prior to twentieth Century and the French mandate over Lebanon from 1920 to 1943.

are performing at the low benchmark in TIMSS since 2003 (Antoun et al., 2023; Chahine, 2011; Mullis et al., 2016, Mullis at el. 2020). This might be due to students' limited proficiency in the language used for mathematics instruction, which in turn impedes conceptual understanding (Chahine, 2011; Dandashly, 2014). Indeed, mathematics and language learning are deeply interwoven (Prediger & Wessel, 2013). Yet, there is very few published research in Lebanon on this topic. In multilingual settings, such as in Lebanon, learners, often encounter academic content and discourse in an unmastered language (Jakobson & Axelsson, 2017; Lee et al., 2019), and so the the role of language is even more prominent.

Mathematics in Lebanon emerged as an obstacle to a number of students with limited foreign language proficiency, stopping them from choosing to pursue higher levels of education (Chahine, 2011). It is believed that understanding mathematics necessitates that both teachers and students master the language of instruction (LOI) as language is the foundation for deep mathematical understanding (Molina, 2012). L2 learners are required to acquire the identical academic content as students learning in L1, while developing proficiency in L2 (Prinsloo & Harvey, 2018). Accordingly, language's pivotal role in students' education emerges as a means of exclusion or inclusion of students in classroom learning (Prinsloo & Harvey, 2018). When the language of instruction is not students' first language, limited proficiency in L2 would hinder them from meaningfully contributing to class discussions and articulating their ideas freely (Brock-Utne, 2013; Dandashly, 2014; Jhagroo, 2015), thus distracting their concentration and attention and, particularly, impeding their capacity to understand and solve mathematical word problems (Dandashly, 2014). Moreover, it has been found that students learning math in first language (L1) achieve better in both subjects, have higher conceptual understanding, and do better on exercises that require higher cognitive levels of thinking than students who are taught using the second language (L2) (Dandashly, 2014; Prediger et al., 2019).

Indeed, language ability is a predictor of the performance of students in math (Abedi & Lord, 2001). In South Africa, where mathematics is taught in L2, one of the factors associated with low performance in TIMSS is a lower frequency of "speaking the language of the test at home" (Juan & Visser, 2017; Prinsloo & Harvey, 2018). This indicates the strong influence of foreign language proficiency on students' performance. More particularly, studies have revealed that the language used in word problems in mathematics influence students' understanding and capacity to resolve the problems, with the difficulties generally lying in the contexts and situations that the problem presents (Schleppegrell, 2007). Indeed, it is through language that mathematical ideas develop (Schleppegrell, 2007). Research has shown that when the language of instruction differs from students' home language, students might face difficulties in academic learning. Ismail and Awang (2008) found that using the language of the test at home had no effect between medium and low achievers but had an effect between the high and medium achievers and high and low achievers.

The impact of the language of instruction on the achievement of Lebanese students in mathematics was examined by Dandashly (2014). Her study showed that Grade 5 and Grade 11 students who had learned math and science in first language (L1) at the elementary level achieved better in both subjects, had higher conceptual understanding, and did better on exercises that require higher cognitive levels of thinking than students who were taught using the second language (L2). Yet, Dandashly's (2014) study did neither take into consideration nor provide information regarding the socioeconomic status (SES) of the Lebanese students who were subjected to the study.

Dandashly's (2014) findings are in accordance with the findings of de Araujo et al. (2018) who examined empirical studies, between 2000 and 2015, that focus on mathematics teaching and learning with K-12 English language learners (ELLs) in various context (e.g. US, Australia, UK, South Africa), in order to get insights into the field's current state. Their review of the literature revealed that the mathematical performance of ELLs is related to their proficiency in both their L1 and their second language (L2). ELLs who are highly proficient in both L1 and L2 have a better performance on mathematical assessments when compared to students who lack proficiency in these languages (Clarckson, 1992; de Araujo et al., 2018; Ní Ríordáin and O'Donoghue, 2009). As Molina (2012) argued, from a language viewpoint, the development of conceptual comprehension requires students to thoroughly master the symbolism and academic language which are essential components of mathematics. This means that students need to have the ability to not only identify and comprehend nuances in the symbolism and language, but also to decipher meanings of symbols and words in various mathematical frameworks and to differentiate the meanings of mathematical words from other potential meanings those words might have.

Present study and research questions

Research questions

In this study, TIMSS data of Lebanese students is explored to better understand the influence of language and other home factors on students' mathematics performance. Close analysis of TIMSS data can help us counter structured inequalities by identifying areas and groups of students that need more support (Perry et al., 2022). As importantly, TIMSS scores can indicate educational effectiveness of mathematics curricula and instruction (Eriksson et al., 2018), and thus inform curricular reforms that have been long overdue in Lebanon, where the most recent reform was carried out in 1997 (with revisions in 2005). Specifically, our study addresses the following questions:

- Is there a difference in the mathematics performance of Lebanese students in TIMSS based on the language of the test (English and French)?
- What home factors affect the students' performance in mathematics in TIMSS?
- Does the frequency in which the language of the test is spoken at home affect the students' performance in mathematics? And how does this vary across the two languages in Lebanon?

Methods

Statistical analyses

For our study, we used the Lebanese 8th grade TIMSS 2015 and TIMSS 2019 data for mathematics (Mullis et al., 2016, 2020). We chose to focus on two years instead of one to see the similarity and differences between the years and to see whether results replicate across the years. Based on a nationally representative sampling by TIMSS, 3873 students were selected from 138 different schools across Lebanon for the TIMSS 2015 exam and 4730 students were selected from 204 schools for the TIMSS 2019 exam. For all analyses, we divided the students by the language of the test (English or French). The number of students and schools in each track (English or French) are presented in Table 1. Some schools have both English and French tracks and one class from each track was sampled.

As our study is concerned with how learners' cultural and language capital can affect students' performance, we focused on language, parents' education level, and home assets (e.g., number of devices, number of books, availability of internet at home, etc.) as variables. If more than 75% of the students owned the asset, then this asset was excluded from the study (e.g. have internet at home, own tablet, have more than one bathroom). Subsequently, the factors that were included in the study were: frequency of the language spoken at home, mother's education level, father's education level, parent involvement, number of books owned, number of devices owned, own a study desk, own a room, own a mobile, own a gaming system, and have a home cinema. Some variables were recoded or reverse coded as needed.

First, we compared the performance of the students in mathematics based on the language of the test, by looking at the means for each language in 2015 and 2019 separately and the TIMSS benchmarks attained for each year. TIMSS has four defined achievement benchmarks (score in parentheses): Low (400), Intermediate (475), High (550) and Advanced (625). Then, to check whether there is a difference in the mathematics scores of students who took the test in English or French we performed and independent t-test for each of the TIMSS 2015 and 2019 data.

Second, using hierarchical linear modelling (HLM) (Raudenbush & Bryk, 2002), we examined whether the performance of students in mathematics was affected by the language and home variables. HLM takes into account that the students are nested within schools; therefore, taking into account students' individual differences and students' grouping in schools (Hox, 2010; Raudenbush & Bryk, 2002). In addition, HLM allows for the use of plausible values which is the form of the TIMSS raw data (Raudenbush & Bryk, 2002; Rutkowski et al., 2010; Von Davier et al., 2009). Furthermore, weights were computed for each level. At the students' level, the students' weight was calculated by multiplying the class weight and the student weight while the school weight was used for the second level (Rutkowski et al., 2010).

For the HLM analysis, first, an unconditional model with students nested within schools was fit to calculate the intra-class correlation (ICC) and determine whether analyzing the data as 2-levels is appropriate (Raudenbush & Bryk, 2002). This HLM analysis was performed for both English and French for both TIMS 2015 and TIMSS 2019. Then, each of the language and home variables was added to the unconditional model at the students' level for each of the English and French tracks for both years to check whether this variable has an effect on students' mathematics performance. In addition, we ran the same HLM test for different content areas within mathematics (Number, Algebra, Geometry, Data and Chance) and the frequency of the language spoken at home to see whether the language affects content areas differently. Lastly, we checked which factors still contributed in explaining the students' mathematics performance, when combined.

Table 1 Number of students and schools in the english and french tracks

	English Track		French Track	
	Number of students	**Number of schools**	**Number of students**	**Number of schools**
TIMSS 2015	1507 (42.8%)	63	2366 (57.2%)	87
TIMSS 2019	2632 (51.8%)	115	2098 (48.2%)	105

Table 2 Performance of 8th grade Lebanese students in math in TIMSS 2015 and 2019

	Language	N	Mean	SD	SE
2015*	English	1507	438.68	73.90	7.07
	French	2366	445.24	76.14	4.54
2019	English	2632	430.82	69.90	4.18
	French	2098	427.68	75.13	5.37

* The difference between English and French was statistically significant (p < .05) in 2015

Table 3 Number of students at each of the TIMSS benchmarks in 2015and 2019

	2015		2019	
	English	French	English	French
Below the Low Benchmark (< 400)	451 (31.06%)	574 (28.27%)	988 (33.59%)	786 (37.86%)
Low Benchmark (400 ≤ x < 475)	556 (36.30%)	790 (35.34%)	1063 (40.44%)	769 (34.47%)
Intermediate Benchmark (475 ≤ x < 550)	404 (25.98%)	743 (28.14%)	487 (21.15%)	440 (21.97%)
High Benchmark (550 ≤ x < 625)	93 (6.41%)	244 (7.79%)	86 (4.36%)	99 (5.52%)
Advanced Benchmark (≥ 625)	3 (0.25%)	15 (0.46%)	7 (0.46%)	3 (0.18%)

Results

General achievement of Lebanese students

Table 2 presents the average performance of students in the English and French tracks in 2015 and 2019. In 2015, as seen in Table 2, the French track students scored higher than the English track students in mathematics and the difference was statistically significant ($p = .008$). On the other hand, in 2019, the English track students scored higher than the French track students but the difference was not statistically significant ($p = .14$).

Using the IEA IDB Analyzer (IEA, 2019) for the TIMSS 2015 and TIMS 2019 data, we extracted the number of students performing at each of the TIMSS benchmarks. As seen in Table 3, more than two thirds (67% and 74%) of the English track students and more than half (64% and 72%) of the French track students scored below the Intermediate Benchmark (low and below low benchmarks) in both years. In 2019, the percentage of students scoring below the Intermediate Benchmark was higher than in 2015 in both English and French. Interestingly, a higher percentage of students scored below the low benchmark in 2019 than in 2015 especially in the French track. Less than 10% of the students were able to attain the High Benchmark across the years. Less than 1% of the students were able to attain the Advanced Benchmark in Mathematics in both the English and the French tracks in 2015 and 2019.

How often the language of the test is spoken at home

Table 4 presents the percentages of students based on how often these students spoke the language of the test at home. More than three quarters of the English track students spoke English at home either "never" or "sometimes" across the two years, whereas in the French track in 2015, around two thirds of the students spoke French at home either "never" or "sometimes" but that number was around 80% in 2019. Mainly, the majority of the students spoke the language of the test "sometimes" at home.

For HLM, the data was divided by TIMSS 2015 and TIMSS 2019 and by the language of the test (English and French) separately. A 2-level unconditional model was fit with students nested within schools for each language and year independently. The Intraclass

Table 4 How often learners speak the language of the test at home

	2015		2019	
ATHOME	**English**	**French**	**English**	**French**
Never	11.1%	15.4%	15.7%	30.5%
Sometimes	67.8%	53%	64.9%	49.9%
Almost Always	14.1%	19%	12.4%	12.7%
Always	7%	12.9%	7%	6.9%

Note. Data from Mullis et al. (2016) *and* Mullis et al. (2020)

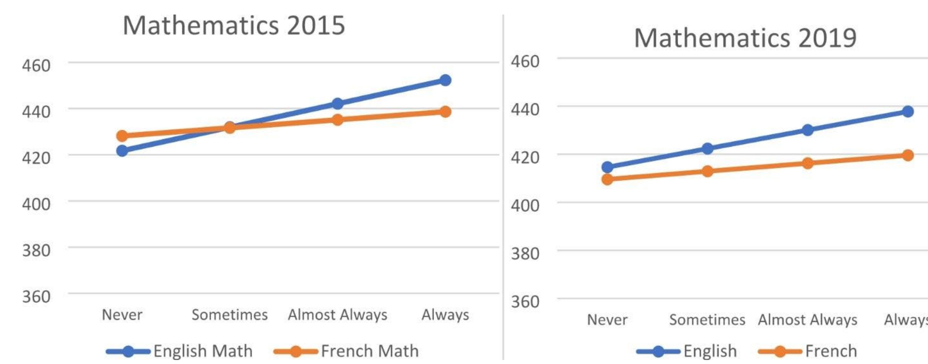

Fig. 1 Difference on average in scores based on the frequency of the language spoken at home

correlation was over 30% for both the English track and the French track and both 2015 and 2019, which are large values according to Hox (2010). Which means that more than 30% of the variance is between schools, therefore, analyzing the data as 2-levels using HLM is appropriate.

The HLM results indicated that the effect of the frequency of the spoken language at home on the students' performance depends on the language of the test, i.e., the effect is not the same for the English and French tracks. In 2015, on average, the difference between the students' scores at each level of the frequency of the spoken language at home was 10.18 points ($p<.001$) for English and 3.49 points ($p=.163$) for French. Which means the difference in mathematics scores, in 2015, on average, between someone who *never* spoke the language of the test at home and someone who *always* spoke the language of the test at home was 30.5 points for English and 10.47 points for French. In 2019, on average, the difference between the students' scores at each level of the frequency of the spoken language at home was 7.72 points ($p=.003$) for English and 3.33 points ($p=.235$) for French. Which means the difference in mathematics scores, in 2019, on average, between someone who *never* spoke the language of the test at home and someone who *always* spoke the language of the test at home was 23.16 points for English and 9.99 points for French. The differences were statistically significant for the English track in both years but not for the French track in either year. In other words, how often students spoke the language of the test at home significantly affected their mathematics scores if they were in the English track but did not significantly affect their mathematics scores if they were in the French track. The graphs in Fig. 1 below show the difference, on average, in the scores of the students depending on the frequency of the language spoken at home in both years.

Within each of the content areas for mathematics, on average, the difference between someone who *never* spoke the language of the test at home and someone who *always* spoke the language of the test at home was between 27 and 39 points for the English track in 2015, and between 8 and 16 points for the French track, in 2015 (see Table 5). The lowest difference in score in mathematics for both English and French tracks was for Number and the highest difference in score was in Data and Chance in 2015. As for 2019, on average, the difference between someone who *never* spoke the language of the test at home and someone who *always* spoke the language of the test at home was between 18 and 44 points for the English track, and 9 and 19 points for the French track. The lowest difference in score for both the English and French tracks was in Geometry. The highest difference in score for both English and French tracks was in Data and Chance. It is interesting to note the low performance of students in both tracks in Data and Chance. Lebanese students have consistently performed lower in Data and Chance than other content areas in TIMSS (see e.g. Younes, 2013). One explanation might be that in 2019 for example, 4 out of the 6 topics of Data and Chance tested in TIMSS were not taught in the Lebanese curriculum in grade 8 (Mullis et al., 2020). Also from the authors' experience and work with teachers, the chapters on data and probability are usually left until the end of the year if the teacher has time and usually not taught.

Home factors

To check which home factors affect students' performance in mathematics, we ran an HLM for each of English and French tracks (2015 and 2019) with each of the home factors. The factors were: mother's education level, father's education level, number of books owned, number of devices owned, own a study desk, own your own room, own a mobile phone, own a gaming device, and own a home cinema. Factors that did not statistically significantly contribute to the students' performance in 2015, neither in the English nor in the French tracks were excluded from the study. The four remaining factors were: mother's education level, father's education level, number of books owned, and number of devices owned. Parents' education level was divided into 4 levels: (a) high school or below, (b) post high school, (c) bachelor's degree, (d) masters or doctorate. The number of books owned was divided into 5 levels: (a) 0–10 books, (b) 11–25, (c) 26–100, (d) 101–200, (e) more than 200. The number of devices found at home was divided into 5 categories: (a) none, (b) 1–3, (c) 4–6 (d) 7–10, (e) more than 10. Unfortunately, the number of devices found at home was not available in the TIMSS 2019 data so it was analyzed for the TIMSS 2015 data only. The rest of the variables were used for both years.

Table 5 The average difference in achievement between someone who "never spoke the language of the test at home" and someone who "frequently spoke the language of the test at home" in content areas

		English	French
2015	Number	27.75*	8.31
	Data and Chance	38.88*	15.56*
	Geometry	32.34*	9.12
	Algebra	31.23*	12.69
	Mathematics	**30.5***	**10.47**
2019	Number	34.26*	18.27*
	Data and Chance	44.43*	18.63
	Geometry	17.91	8.67
	Algebra	20.01*	10.35
	Mathematics	**23.16***	**9.99**

* $p < .05$

Table 6 Differences in scores between first and last levels of home factors

	English		French	
	2015	**2019**	**2015**	**2019**
Mother's Education Level	11.91	28.53*	21.06*	22.32*
Father's Education Level	17.28	22.98*	26.07*	21.15
Number of Devices at Home	29*	NA	33.24*	NA
Number of Books at Home	31.52*	19.64*	37.2*	16.52*

* *p < .05*

Table 7 Factors affecting students' performance in mathematics

	English Track				French Track			
	2015		**2019**		**2015**		**2019**	
	Coefficient	**P Value**	**Coefficient**	**P Value**	**Coefficient**	**P Value**	**Coefficient**	**P Value**
Frequency of spoken language at home	8.44*	0.034	7.46*	0.005	NA	NA	NA	NA
Mother's Education	NA	NA	7.30*	< 0.001	3.02	0.228	7.11*	0.002
Father's Education	NA	NA	3.92	0.101	4.04	0.16	NA	NA
Number of Devices at Home	5.63*	0.032	NA	NA	6.31*	0.037	NA	NA
Number of Books at Home	5.84*	0.019	2.14	0.346	6.04	0.132	4.82*	0.046

* *p < .05*

The effect of the four factors on students' scores between the lowest level and the highest level of each factor is presented in Table 6. All four factors contributed statistically significantly to the students' scores in the French in 2015 but only the mothers' education and the number of books had significant contributions in 2019. In the English track, only the number of books and the number of devices at home significantly affected students' mathematics scores in 2015, but, both parents' education level and the number of books affected the students' scores in 2019.

To check which factors still affected students' performance after controlling for other factors, a 2-level HLM model was fit with the factors that were statistically significant for each of English and French tracks for 2015 and 2019 separately. The coefficients for each factor are presented in Table 7. The coefficients represent in general the amount of change each one unit of the factor contributes to the change in the students' performance scores and whether this change is statistically significant.

For the English track, how often the language of the test was spoken at home, the number of books, and the number of devices still statistically significantly affected the students' performance in 2015 while frequency of the language spoken at home and mothers' education significantly affected the students' scores in 2019. For the French track, how often students spoke the language of the test at home, parents' education, and the number of books found at home did not contribute significantly to students' performance in mathematics in 2015. Only the number of devices found at home significantly affected the students' mathematics performance in 2015. In 2019, the mother's education level and the number of books at home significantly affected students' performance in mathematics.

Discussion

Lebanese students' low performance in TIMSS is a source of concern (Tables 2 and 3), with more than 60% of students across language tracks (French and English) performing at the low and below the low Benchmark in 2015 and 2019. In 2015, around 33% of the English track students and 36% of the French track students scored at or above the Intermediate benchmark. In 2019, only around 26% of the English track students and 28% of the French track students scored at or above the Intermediate Benchmark. Additionally, the percentage of students scoring at the Intermediate Benchmark or higher in mathematics decreased from 2015 to 2019, indicating that, across tracks, students demonstrate basic knowledge of concepts rather than being able to engage deeply with mathematics by communicating and applying mathematical knowledge in everyday and abstract contexts. In line with previous research (e.g., Ersan and Rodriguez, 2020; Huang and Liang, 2016; Perry et al., 2022), we found that not speaking the language of the test at home and other home factors; mainly mother's education level, father's education level, number of books and devices owned; had varying but mostly significant contribution to students' mathematics scores. After controlling for other factors and excluding factors that did not contribute significantly, the mother's education level was significantly associated with Lebanese students' mathematics performance for both the English and French track students in 2019. A mothers' education level is not only an SES-indicator, but may also reflect kinds of support they provide for their children. "*Frequency of speaking the test language at home*" was significantly associated with higher mathematics scores for the *English track* students across both years (Table 7), indicating that students in the English track who spoke the language of the test more frequently at home were more likely to perform better in mathematics in both years. In the 2015 TIMSS, the number of devices owned was significantly associated with higher mathematics scores in both tracks. Number of devices owned can also be a SES indicator, in the sense that more affluent parents can afford to buy more devices and possibly give their children more access to information.

The various SES indicators intersect substantially, particularly with speaking the foreign language at home. A higher educational level of parents indicates higher proficiency in a foreign language, as almost all higher-education institutions in Lebanon adopt English or French as the language of instruction, therefore, parents that are more educated can provide more opportunities for their children to develop proficiency in the foreign language (e.g., access to more books). Moreover, as mentioned above, parents with higher educational level are more likely to have better paying jobs, which would be reflected in the number of books and devices owned.

Limited proficiency in the language of instruction influences learners' performance and conceptual understandings; for example, Perry et al. (2022) found that, in addition to being an Indigenous Australian, not speaking English at home had significant negative relationships with PISA performance in all three subjects. Similarly, in South Africa, Prinsloo and Harvey (2018) found that one of the factors associated with low performance in TIMSS is a lower frequency of "speaking the language of the test at home." From a sociocultural perspective, disciplines, including mathematics, have unique ways of constructing and communicating knowledge (disciplinary-discourses) (Lemke, 2005), whereby students' meaningful engagement in disciplinary practices and discourse is a significant segue to deep learning (Moore & Schleppegrell, 2020). Students deploy language to explain mathematics concepts and carry out procedures: through such interactions, they reason about the mathematical concepts and develop understanding (Fernandez, 2023). If students are only allowed to use the language of instruction in content classes, which is the case in many Lebanese mathematics and science classes (Salloum, 2021), then learners' contribution to class discussions and articulation of mathematical ideas are suppressed due to limited foreign language proficiency. The language of mathematics can be challenging to all learners, and even more so to multilingual learners, who would be at a disadvantage lest provided with purposeful and strategic scaffolds as they navigate and build on their various linguistic resources (Salloum, 2021; Prediger et al., 2019).

Accordingly, students' access to higher levels of disciplinary literacy in mathematics can be constrained by their level of foreign language proficiency, which may very well restrict their access to dominant discourses and employment opportunities in a highly technological global economy. According to Shuyab (2016), designating a foreign language to teach science and mathematics, without providing the necessary supports and opportunities to develop adequate language proficiency, has resulted in structural barriers that especially disadvantage and marginalize students from economically depressed groups; thus sustaining what has been termed as 'linguistically structured inequalities' (McCarty et al., 2011). In Lebanon, dropout rates (especially for lower SES boys) are at their highest in grades 6 and 7 when all schools have to shift to teaching science and mathematics in the foreign language. Our results further highlight inequities connected to language and home factors, whereby the various home factors connected to SES significantly contributed to students' achievement in mathematics. Thus, issues of social justice, power distribution, and equity are seemingly undermined and consequently unaddressed in our educational system (de Araujo et al., 2018; Shuyab, 2016; Tamim, 2014).

Not speaking the test language at home did not have the same effect on mathematics performance in the French track. The differences between the two tracks are interesting and can afford various interpretations. In Lebanon, English is regarded as an international and modern language for science, trade, and technology; and French is regarded as a language of education and culture and even more importantly as an identity marker for certain Lebanese groups (Diab, 2009; Orr & Annous, 2018; Shaaban & Ghaith, 1999). The French's language status as an identity marker may have undermined the influence of the frequency of speaking the foreign language at home for Lebanese groups who perceive French as a *second language* rather than the *foreign language* and have historically spoke it at home regardless of SES. It could be that for this group, other SES factors associated with cultural capital, such as the mother's educational level, emerged stronger in relation to the TIMSS achievement.

There is a reason to believe that another contextual practice may have mediated the negative effect of not speaking the language of the test at home in the French schools. In Lebanon, it is not uncommon for more affluent English-Educated[2] parents to send their children to prestigious private French schools to give them the advantage of a third

[2] In Lebanon, many identify as English-educated or French-educated based on the dominant foreign language in the schools they attended.

language, thus enhancing their children's economic opportunity (Baladi, 2018; Dagher & BouJaoude, personal communication). Such private schools usually have more qualified teachers and are better resources for building students' language proficiency, even when the foreign language is not frequently deployed at home. Therefore, such students, even if they do not speak French at home, are more likely to have parents, and especially mothers, who are highly educated, thus neutralizing the influence of not speaking the language of the test at home.

Conclusion and implications

All students need to be enabled for developing their cultural capital and gaining higher educational credentials. Lebanese students' overall low performance indicates that they are experiencing school mathematics as facts and skills that are mostly detached from their daily lives. A possible cause of such state is outdated and inflexible curricula and the persistence of traditional content-centered approaches that target lower-level learning rather than interactive inquiry-based teaching and learning. Learners' mathematics TIMSS performance seems to also be associated with different SES indicators, mainly home and family assets and foreign language proficiency. In this paper, we tried to show interrelations between different SES factors and foreign language as the medium of instruction and mathematics achievement, especially in terms of its implications for students from disadvantaged groups. Our results suggest that designating a foreign language as the medium of instruction intersects with other SES factors and contributes to educational inequities.

An "idealistic" implication of this research at the national level would involve equitable allocation of human and physical resources in schools to narrow gaps among students from different socio-economic strata (Salloum, 2021; Perry et al., 2022). On a more practical level, quality teaching and learning that promotes deeper conceptual learning requires high levels of interactions and collaboration for students to construct meanings, connect prior ideas to new ones and express understandings, and so requires high language proficiency in both the home and foreign language (Barwell, Wessel & Parra, 2019; Lee et al., 2019). Reaching this goal requires curricular reforms and compels us as teacher educators to better prepare mathematics teachers for responsive teaching that is addresses the needs of socio-economically diverse learners. Such preparation requires transforming mathematics teachers' views on how language and mathematics are intricately connected (Fernandez, 2023), and developing their competence for practices and strategies that support diverse students' mathematics learning (Prediger et al., 2019). Both instructional materials (e.g., textbooks) and teacher preparation need to highlight critical awareness of how language is used in mathematics to construct present, and represent knowledge, thus enabling and empowering students to participate and expand their mathematical linguistic repertoires (Schleppegrell, 2020).

Multilingualism is an important identity marker for the Lebanese, who view Lebanon as a global economy and as a 'bridge' connecting the East and the West (Baladi, 2018; Tohme, 2019); hence, maintaining a multilingual education policy coheres with such identity marker. However, in addition to responding to the society's needs, it is also important for education to respond to diverse learners' needs. In our global environment, innovation in science and technology can drive growth and improve quality of life, and so our curricula (content and teaching methods) and teacher education need to be reformed to as to build content through linguistically responsive and interactive teaching approaches that involve students in collaboratively solving meaningful problems and designing creative solutions, while building on diverse learners' holistic linguistic resources (e.g., home language) and supporting their language needs (Gajderowicz & Jakubowski, 2022; Prediger et al., 2019). It is then that we can aspire for empowered learners who apply mathematical knowledge, communicate it and reason with it for a better future.

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Data Availability
All data generated or analysed during this research study are included in the manuscript.

Declarations

Competing interests
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References

Abedi, J., & Lord, C. (2001). The language factor in mathematics tests. *Applied Measurement in Education*, *14*(3), 219–234. https://doi.org/10.1207/S15324818AME1403_2.

Antoun, M., Younes, R., & Salloum, S. (2023). Investigating the status of highly able students through the lens of the Lebanese national policy and the mathematics and science centralized curricula and textbooks. *European Journal of Science and Mathematics Education, 11*(2), 215-233. https://doi.org/10.30935/scimath/12569

Assaf, F., & Graves, B. (2019). It's not a calculator thingy because a calculator can't answer the question: Multilingual children's mathematical reasoning. *Research in Mathematics Education*, *21*(2), 168–187. https://doi.org/0.1080/14794802.2019.1618730.

Baladi, S. S. (2018). Polyglotism and Identity in Modern-Day Lebanon. *Lingua Frankly*. https://doi.org/10.6017/lf.v4i0.9611. *4*.

Baliyan, S. P., Rao, K. S. M., & Baliyan, P. S. (2012). Influence of parental education and income level on students' performance in senior secondary schools in Botswana. *Global Research Journal on Mathematical and Science Education*, *1*(2), 135–158.

Barwell, R., Wessel, L., L., & Parra, A. (2019). Language diversity and mathematics education: New developments. *Research in Mathematics Education*, *21*(2), 113–118. https://doi.org/10.1080/14794802.2019.1638824.

Bourdieu, P. (1977). In J. C. Passeron (Ed.), *Reproduction in Education, Society and Culture* (,Richard Nice Trans.). London: SAGE Publication Ltd.

Bourdieu, P. (1999). *Language and symbolic power. Cambridge*. MA. Polity. (Original work published 1991).

Brock-Utne, B. (2013). Language of instruction and learning in mathematics and science in some african countries. *African and Asian Studies*, *12*(1–2), 83–99. https://doi.org/10.1163/15692108-12341252.

Center for Educational Research and Development (CERD) (2020). Statistical bulletin: Academic Year 2019–2020. Retrieved from https://www.crdp.org/sites/default/files/2021-06/Stat_Nashra_Inside_2020_V_5_0.pdf.

Chahine, I. (2011). The role of translations between and within representations on the conceptual understanding of fraction knowledge: A trans-cultural study. Journal of Mathematics Education, 4(1), 47–59. Retrieved from https://pdfs.semanticscholar.org/0f24/d5672fa8fe00b97d2c1026db602a50d1c75e.pdf.

Chahine, I., Post, T., & del Mas, R. (2011). The effect of using a research-based curriculum on learning basic rational number concepts by lebanese students. *Near and Middle Eastern Journal of Research in Education*, *3*, https://doi.org/10.5339/nmejre.2011.3.

Clarkson, P. C. (1992). Language and mathematics: A comparison of bi and monolingual students of mathematics. *Educational Studies in Mathematics*, *23*, 417–429.

Dandashly, N. A. (2014). The effects of the language of instruction in the science and math achievement of lebanese students [Unpublished master's thesis, lebanese American University]. *Lebanese American University Library Catalog*. https://doi.org/10.26756/th.2014.2.

de Araujo, Z., Roberts, S. A., Willey, C., & Zahner, W. (2018). English learners in K–12 mathematics education: A review of the literature. *Review of Educational Research*, *88*(6), 879–919. https://doi.org/10.3102/0034654318798093.

De Graaf, N. D., De Graaf, P. M., & Kraaykamp, G. (2000). Parental Cultural Capital and Educational Attainment in the Netherlands: A refinement of the Cultural Capital Perspective. *Sociology of Education*, *73*(2), 92–111. https://doi.org/10.2307/2673239.

Diab, R. R. (2009). Lebanese university student's perceptions of ethnic, national, and linguistic identity and their preferences for foreign language learning in Lebanon. *Linguistics Journal*, *4*, 101–120.

El Mouhayar, R. R., & Jurdak, M. E. (2013). Teachers' ability to identify and explain students' actions in near and far figural pattern generalization tasks. *Educational Studies in Mathematics*, *82*, 379–396. https://doi.org/10.1007/s10649-012-9434-6.

Eriksson, K., Helenius, O., & Ryve, A. (2018). Using TIMSS items to evaluate the effectiveness of different instructional practices. *Instructional Science 47*, 1–18 (2019). https://doi.org/10.1007/s11251-018-9473-1.

Ersan, O., & Rodriguez, M. C. (2020). Socioeconomic status and beyond: A multilevel analysis of TIMSS mathematics achievement given student and school context in Turkey. *Large-scale Assess Educ*, *8*, 15. https://doi.org/10.1186/s40536-020-00093-y.

Farooq, M. S., Chaudhry, A., Shafiq, M. M., & Berhanu, G. (2012). Factors affecting students' quality of academic performance: A case of secondary school level. *Journal of Quality and Technology Management*, *7*, 01–14.

Fernandes, A. (2023). Understanding mathematics preservice teachers' beliefs about English learners using the Mathematics Education for English Learners Scale (MEELS). *Bilingual Research Journal*. https://doi.org/10.1080/15235882.2023.2169406. (Advance online publication).

Gajderowicz, T. J., & Jakubowski, M. J. (2022). *Jordan and lebanon performance in international student assessments*.).Washington, DC: World Bank.

Hox, J. J. (2010). Quantitative methodology series. *Multilevel analysis: Techniques and applications* (2nd ed.). New York, NY, US: Routledge/Taylor & Francis Group.

Huang, H., & Liang, G. (2016). Parental cultural capital and student school performance in mathematics and science across nations. *The Journal of Educational Research*, *109*(3), 286–295. https://doi.org/10.1080/00220671.2014.946122.

IEA (2019). *Help Manual for the IEA IDB Analyzer (Version 5.0)*Retrieved from https://www.iea.nl/sites/default/files/2022-06/IDB-Analyzer-Manual-%28Version-5-0%29.pdf.

Ismail, N. A., & Awang, H. (2008). Assessing the effects of students' characteristics and attitudes on mathematics performance. *Problems of Education in the 21st Century*, *9*, 34–41.

Jakobson, J., & Axelsson, J. (2017). Building a web in science instruction: Using multiple resources in a swedish multilingual middle school class. *Language and Education*, *31*, 479–494. https://doi.org/10.1080/09500782.2017.1344701.

Jhagroo, J. R. (2015). I know how to add them, I didn't know I had to add them. *Australian Journal of Teacher Education*, *40*(11), https://doi.org/10.14221/ajte.2015v40n11.6.

Juan, A., & Visser, M. (2017). Home and school environmental determinants of science achievement of south african students. *South African Journal of Education*, *37*(1).

Kodippili, A. (2011). Parents' education level in students' mathematics achievement; Do school factors matter? *Academic Leadership: The Online Journal*, 9(1), Article 39. Available at: https://scholars.fhsu.edu/alj/vol9/iss1/39.

Lee, O., Llosa, L., Grapin, S., Haas, A., & Goggins, M. (2019). Science and language integration with English learners: A conceptual framework guiding instructional materials development. *Science Education*, *103*(2), 317–337. https://doi.org/10.1002/sce.21498.

Lemke, J. L. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching*, *38*(3), 296–316.

Lemke, J. L. (2005). Multimedia semiotics: Genres for science education and scientific literacy. In M. J. Schleppegrell & M. C. Colombi (Eds.), *Developing advanced literacy in first and second languages: Meaning with power* (pp. 21–44). Routledge. ProQuest Ebook Central. http://ebookcentral.proquest.com/lib/univbal-ebooks/detail.action?docID=227493.

McCarty, T. L., Collins, J., & Hopson, R. K. (2011). Dell Hymes and the new language policy studies: Update from an underdeveloped country. *Anthropology & Education Quarterly*, *42*, 335–363.

Moje, E. B. (2015). Doing and teaching disciplinary literacy with adolescent learners: A social and cultural enterprise. Harvard Educational Review, 85(2), 254–278,301. Retrieved from http://ezsecureaccess.balamand.edu.lb/login?url=https://search-proquest-com.ezsecureaccess.balamand.edu.lb/docview/1691427618?accountid=8475.

Moore, J., & Schleppegrell, M. (2020). A focus on disciplinary language: Bringing critical perspectives to reading and writing science. *Theory Into Practice*, *59*(1), 99–108. https://doi.org/10.1080/00405841.2019.1685337.

Molina, C. (2012). *The problem with math is English: A language-focused approach to helping all students develop a deeper understanding of mathematics* (1st ed.). San Francisco, Calif: Jossey-Bass.

Moschkovich, J. N. (2018). Recommendations for research on language and learning mathematics. *Language and communication in mathematics education* (pp. 37–47). Cham: Springer International Publishing. doi:https://doi.org/10.1007/978-3-319-75055-2_4http://link.springer.com/10.1007/978-3-319-75055-2_4.

Moschkovich, J. N., Wagner, D., Bose, A., Rodrigues Mendes, J., & Schütte, M. (2018). Language and communication in mathematics education: International perspectives. Switzerland, Cham: Springer. https://doi.org/10.1007/978-3-319-75055-2.

Mullis, I. V. S., Martin, M. O., & Foy, P. (2016). *TIMSS 2015 International results in Mathematics*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). *TIMSS 2019 International results in Mathematics and Science*. Retrieved from Boston College, TIMSS & PIRLS. https://timssandpirls.bc.edu/timss2019/international-results/ International Study Center website.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

Ní Ríordáin, M., & O'Donoghue, J. (2009). The relationship between performance on mathematical word problems and language proficiency for students learning through the medium of irish. *Educational Studies in Mathematics*, *71*(1), 43–64. https://doi.org/10.1007/s10649-008-9158-9.

Orr, M., & Annous, S. (2018). There is no alternative! Student perceptions of learning in a Second Language in Lebanon. *Journal of Language and Education*, *4*(1), 79–91. https://doi.org/10.17323/2411-7390-2018-4-1-79-91.

Perry, L. B., Saatcioglu, A., & Mickelson, R. A. (2022). Does school SES matter less for high-performing students than for their lower-performing peers? A quantile regression analysis of PISA 2018 Australia. *Large-scale assessments in education*, *10*(1), 17. https://doi.org/10.1186/s40536-022-00137-5.

Post, T., Chahine, I., & del Mas, R. (2011). The effect of using a research-based curriculum on learning basic rational number concepts by Lebanese students. *Near and Middle Eastern Journal of Research in Education, (2011)*1, 1–9. https://doi.org/10.5339/nmejre.2011.3.

Prediger, S., & Wessel, L. (2013). Fostering german-language learners' constructions of meanings for fractions—design and effects of a language- and mathematics-integrated intervention. *Mathematics Education Research Journal*, *25*, 435–456. https://doi.org/10.1007/s13394-013-0079-2.

Prediger, S., Kuzu, T., Schüler-Meyer, A., & Wagner, J. (2019). One mind, two languages – separate conceptualisations? A case study of students' bilingual modes for dealing with language-related conceptualisations of fractions. *Research in Mathematics Education*, *21*(2), 188–207. https://doi.org/10.1080/14794802.2019.1602561.

Prinsloo, C. H., & Harvey, J. C. (2018). The differing effect of language factors on science and mathematics achievement using TIMSS 2015 data: South Africa. *Research in Science Education*. https://doi.org/10.1007/s11165-018-9769-9.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.

Rutkowski, L., Gonzalez, E., Joncas, M., & von Davier, M. (2010). International large scale Assessment Data: Issues in secondary analysis and reporting. *Educational Researcher*, *39*, 142–151.

Salloum, S. (2021). Intertextuality in science textbooks: implications for diverse students' learning. *International Journal of Science Education, 43*(17), 2814-2842, https://doi.org/10.1080/09500693.2021.1992530

Schleppegrell, M. J. (2007). The linguistic challenges of mathematics teaching and learning: A research review.*Reading & Writing Quarterly, 23*(2), 139–159. https://doi.org/10.1080/10573560601158461.

Shaaban, K., & Ghaith, G. (1999). Lebanon's language-in-education policies: From bilingualism to trilingualism. *Language Problems and Language Planning*, *23*(1), 1–16. https://doi.org/10.1075/lplp.23.1.01leb.

Shuayb, M. (2016). Education for social cohesion attempts in Lebanon: Reflections on the 1994 and 2010 education reforms. *Education as Change*, *20*(3), 225–242. https://doi.org/10.17159/1947-9417/2016/1531.

Sullivan, A. (2001). Cultural capital and educational attainment. *Sociology*, *35*(4), 893–912.

Tamim, T. (2014). The politics of languages in education: Issues of access, social participation and inequality in the multilingual context of Pakistan. *British Educational Research Journal*, *40*(2), 280–299.

Teachman, J. D. (1987). Family background, educational resources, and educational attainment. *American Sociological Review*, *52*(4), 548–557.

Tohme, S. (2019). Language creativity: A sociolinguistic reading of linguistic change in Lebanon. *BAU Journal-Society Culture and Human Behavior*, *1*(1), 2.

von Davier, M., Gonzalez, E., & Mislevy, R. (2009). Plausible values: What are they and why do we need them? *IERI Monograph Series: Issues and Methodologies in Large-Scale Assessments*, *2*, 9–36.

Vygotsky, L. S., & Vygotsky (1983). L.S (1983). Thinking and speech. Belgrade: Nolit.

Younes, R. (2013). *The Relationship of Student Dispositions and Teacher Characteristics with the Mathematics Achievement of Students in Lebanon and Six Arab Countries in TIMSS 2007* (Publication No. 3572214). [Doctoral dissertation, Texas A&M University]. ProQuest Dissertations & Theses Global.

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